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GEOLOGICAL MAGAZINE.

VOL. V.

JANUARY—DECEMBER, 1868.

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THE
GEOLOGICAL MAGAZINE;

OR,

Monthly Journal of Geology:

WITH WHICH IS INCORPORATED

"THE GEOLOGIST."

NOS. XLIII. TO LIV.

EDITED BY

HENRY WOODWARD, F.G.S., F.Z.S.

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OF NATURAL HISTORY, NEW YORK.

ASSISTED BY

PROFESSOR JOHN MORRIS, F.G.S., &c., &c.,

AND

ROBERT ETHERIDGE, F.R.S.E., F.G.S., &c.

VOL. V.

JANUARY—DECEMBER, 1868.

LONDON:
TRÜBNER & Co., 60, PATERNOSTER ROW.
CH. DELEGRAVE ET CIE, 78, RUE DES ECOLES, PARIS.
LEIPSIC: F. A. BROCKHAUS.
TURIN & FLORENCE: H. LOESCHER. NEW YORK: LEYPOLDT & HOLT.
1868.

HERTFORD:
PRINTED BY STEPHEN AUSTIN.

210731

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[1] Roughly copied from the Geological Survey Map.—W.W.

PREFACE.

In closing the Fifth Volume of the GEOLOGICAL MAGAZINE, we cannot omit to express our sincere thanks to our numerous friends, especially to those who have furnished the ORIGINAL ARTICLES, which, as a matter of course, are the very foundation of this volume. We welcome some as new Geological contributors, but the chief names are of old and valued supporters who have from the outset given us their aid.

Our volume for 1868 contains articles by Messrs. T. P. Barkas; Thos. Belt, C.E., F.G.S.; E. Billings, F.G.S.; W. Carruthers, F.L.S., F.G.S,; Thos. Davidson, F.R.S., F.G.S.; D. C. Davies; T. Davies; W. Boyd Dawkins, M.A., F.R.S; C. E. De Rance; J. Evans, F.R.S., Sec. G.S.; R. Etheridge, F.R.S.E., F.G.S,; Miss Eyton; Rev. O. Fisher, M.A., F.G.S.; Messrs. David Forbes, F.R.S., F.G.S.; Archibald Geikie, F.R.S.L. & E.; James Geikie; J. R. Gregory; Prof. C. H. Hitchcock; T. McKenny Hughes, B.A., F.G.S.; Dr. T. Sterry Hunt, F.R.S.; Capt. F. W. Hutton, F.G,S.; Prof. T. H. Huxley, LL.D., F.R.S., President Geol. Soc.; Prof. T. Rupert Jones, F.G.S.; Messrs. J. Beete Jukes, M.A., F.R.S., &c.; G. H. Kinahan, F.R.G.S.I.; E. Ray Lankester, B.A.; H. Leonard, F.G.S.; J. Logan Lobley, F.G.S; Dr. G. Lindström; Dr. C. Lütken; Messrs. D. Mackintosh, F.G.S.; G. Maw, F.L. and G.S.; C. J. A. Meyer; Prof. J. Morris, F.G.S.; Sir Roderick I. Murchison, Bart., F.R.S. &c.; Dr. H. A. Nicholson, M.B., F.G.S.; Messrs. S. R. Pattison, F.G.S.; C. W. Peach; John Ruskin, M.A., LL.D., F.G.S.; G. Poulett Scrope, F.R.S., F.G.S.; S. H. Scudder; H. G. Seeley, F.G.S.; S. Sharp, F.S.A., F.G.S.; Revs. W. S. Symonds, M.A., F.G.S.; J. S. Tute, M.A.; Messrs. J. F. Walker, B.A., F.G.S.; J. M. Wilson, M.A., F.G.S.; S. V. Wood, junr., F.G.S.; B. H. Woodward, &c.

Besides these, we are indebted for NOTICES and REVIEWS to many gentlemen whose names we have not authority to publish, but to whom we sincerely tender our thanks.

Nor have we failed to receive a goodly array of Letters, which, like the Original Articles, treat '*de omnibus rebus et quibusdam aliis*' in Geology and Palæontology, and, as far as our space has permitted, we have given to each and all a place. We must, however, again beg our Correspondents to make their letters as concise as possible, so as to allow of the insertion of as much variety both of matter and opinion as can be; bearing in mind that a single letter by its length often shuts out several other communications equally deserving of a place.

In the matter of Typography and Illustrations, the Artists, Printers, and Publishers have done their very best; and if only more Subscribers will lend us their aid, we promise them a hundredfold in return.

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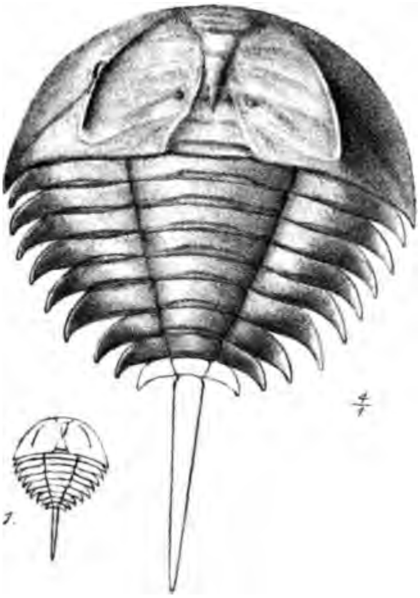

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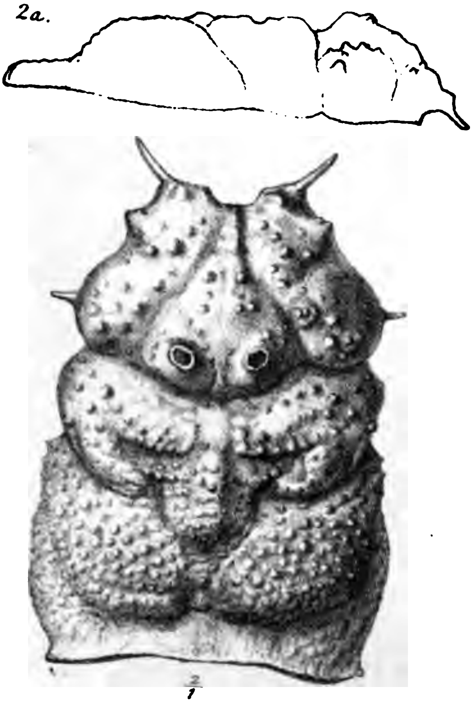

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Fig 1. New Limuloid Crustacean from the U. Silurian.
– Prosopon mammillatum, H. W. Stonesfield

W West

THE
GEOLOGICAL MAGAZINE.

No. XLIII.—JANUARY, 1868.

ORIGINAL ARTICLES.

I.—On a New Limuloid Crustacean [*Neolimulus falcatus*] from the Upper Silurian of Lesmahagow, Lanarkshire.

By Henry Woodward, F.G.S., F.Z.S.

(PLATE I. Fig. 1.)

In a paper which I communicated to the Geological Society of London, Nov. 21, 1866,[1] ("On some points in the structure of the *Xiphosura*, having reference to their relationship with the *Eurypterida*") I have recorded all the then known genera both of *Xiphosura* and of *Eurypterida*, and in the tables which accompany the first part of my Monograph on the *Merostomata*,[2] I have given both the genera and species with their range in time and space.

Although it will be seen, by a reference to the last-named work, that none of the *Xiphosura* have hitherto been found in strata older than the Coal-measures, yet I have pointed out the existence of certain Silurian forms (included by me in the sub-order *Eurypterida*), which indicate a passage—as it were—between the *Eurypteridæ* and *Pterygoti* proper, and the *Limulidæ*.[3]

It was with extreme interest therefore, that I obtained from Mr. Robert Slimon, in September last, the first evidence of the existence of a true Limuloid form of Crustacean from the Uppermost Silurian shales of Lanarkshire.

It is hardly possible to estimate too highly the persevering labours of Mr. Slimon and his sons in the investigation of these Lesmahagow deposits, and one is led to reflect what an enormous amount of additional knowledge would result, if other local geologists devoted themselves with the same energy to the investigation of the rocks of their own particular district.

Unlike the majority of the Crustacea obtained from these deposits, our present acquisition cannot be classed among the giants of those days, the specimen only measuring five and a half lines in greatest length and six lines in greatest breadth. It is preserved upon the extreme edge of a piece of shale, so that, unfortunately, the ultimate segment, as I conceive, and the telson or tail-spine are wanting through being cut off by a cleavage-plane. I have allowed the artist to indicate their probable size in outline, in Plate I. Fig. 1 *a*; the rest of the figure, actually preserved in the fossil, being shaded.

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[1] See Quart. Journ. Geol. Soc. Feb. 1867. Vol. xxiii. p. 28. Pl. I. and II.

[2] Palæontographical Society, vol. xix. December 1866.

[3] Quart. Journ. Geol. Soc. vol. xxiii. p. 31. Pl. I. figs. 3–6.

The head-shield is nearly two-thirds broader than long, the front margin is semicircular and smooth, and the latero-posterior angles are acute and directed backwards. The posterior border of the head is concave, curving slightly inwards near the centre, and backwards towards the latero-posterior angles.

The glabella is semicircular and has a tolerably well-defined lateral border, separating it from the cheek, but it approaches to, and unites with the border of the head-shield in front. A line (which may correspond with the facial suture in Trilobites) passes from the latero-posterior horns of the head-shield, obliquely across the cheeks, and unites with the lateral border of the glabella just where the compound eyes are faintly indicated. (See Pl. I. Fig. 1 *a*.) A raised V-shaped lobe, having its apex directed backwards, marks the centre of the glabella: near its apex four minute dots are visible under the microscope, these are most probably the larval eye-spots or ocelli. From the sides of this V-shaped lobe two corresponding lines diverge and unite with the posterior border, whilst the lateral ridges marking the semicircular border of the glabella curve inwards on approaching the posterior border of the head-shield and unite with the median lines near the ocelli. The segments succeeding the head-shield are free, and are strongly trilobed, the ends of the pleuræ are all distinct and falcate. The first six segments are thoracic; the abdomen probably consisted of three segments, followed by an ensiform telson, but only two of these segments are preserved. The breadth of the segments diminishes rapidly backwards, the first thoracic measuring five lines across, whilst the sixth is only three lines, but the depth of each segment is nearly uniform. The form which appears to possess the same number of segments is the genus *Hemiaspis*, from the Lower Ludlow of Leintwardine, in which we find six thoracic and three abdominal segments; but, with this exception, our Lanarkshire fossil is a much more Limuloid form than *Hemiaspis*, reminding one strongly of Mr. Baily's *Belinurus reginæ* from the Irish Coal-measures; from this latter, however, it is also easily separable, both in its general form, and also in the non-anchylosed condition of the abdomen. From the genus *Prestwichia* it is also separated by the free condition of *all* its segments.

Another new form of *Limulus* (*Belinurus Danæ*) from the Coal-measures of Illinois, U.S., has been described by Messrs. Meek and Worthen,[1] for which Mr. Meek has since proposed the generic name of *Euproops*, in allusion to the anterior position of its eyes.[2] This new form is considered by Mr. Meek to be more near *Prestwichia anthrax*, than to *Belinurus*, by reason of its anchylosed segments, but he considers that it differs from the former in the comparatively small and quadrangular form of the glabella.[3]

[1] Geological Survey of Illinois, 1866, vol. ii.; Palæontology, p. 395, Pl. 32, fig. 2.

[2] Geol. Mag. 1867, Vol. IV. p. 320.

[3] Having, through the kindness of Mr. Prestwich, F.R.S., the type-specimens of his *Limulus* (*Prestwichia*) *anthrax* in my possession, I am the more able to appreciate Mr. Meek's comparison of *Euproops Danæ* with that species. It seems hardly possible to do more than separate them specifically: of their generic identity, I think there can be no doubt.

Not being able to refer the Lanarkshire specimen to any previously described genus of *Xiphosura*, I propose to name it *Neolimulus falcatus*.[1]

I shall not now venture to discuss the affinities of the *Xiphosura* with the *Trilobita*, a point on which I am deeply interested; first, on account of want of information as to their appendages, and secondly, because I believe that a better knowledge of the *larval stages* of the recent *Limulus* is essential to a true explanation of these earliest representatives of the group in past time. Dr. Anton Dohrn of Jena, and Prof. O. C. Marsh of Yale College, Ct., and several other able naturalists have promised me their aid in this interesting inquiry, which, to be carried out in a proper manner, necessitates a temporary residence on the N.E. Coast of North America or the coast of China or Japan, where living King-crabs abound.

EXPLANATION OF PLATE I., Fig. 1, 1*a*.

Fig. 1. *Neolimulus falcatus*, H. Woodw. Natural size (the tail-spine and last segment restored) from the Uppermost Silurian shales of Lesmahagow, Lanarkshire.

Fig. 1*a*. The same magnified four times.

The original specimen is now in the British Museum.

II.—ON A NEW BRACHYUROUS CRUSTACEAN (*PROSOPON MAMMILLATUM*), FROM THE GREAT OOLITE, STONESFIELD.

By HENRY WOODWARD, F.G.S., F.Z.S.

[PLATE I., Fig. 2.]

AMONG the new Oolitic Crustacea to which I drew attention at the meeting of the British Association, Dundee, was a species of *Prosopon* from the Stonesfield Slate.

This genus was proposed by H. von Meyer, in 1835, for certain minute forms of crustacea from the Upper White Jura of Oerlinger Thal, and other localities in Germany, from whence he has described twenty-nine species, and in addition to these, one from the Lower Oolite, three from the Coral Rag, and one from the Neocomian (see *Palæontographica*, for December, 1860, vol. vii., p. 183, pl. xxiii.)

In it, however, are included forms belonging to a very distinct family which cannot be placed with the *Corystidæ*. A similar form to these, from our own Greensand, has been figured and described by Professor Bell in his Monograph on the Fossil Malacostracous Crustacea (Palæontographical Society, 1862, Part ii., p. 9, pl. ii.), and is correctly referred by him to the *Pinnotheridæ*, under the generic name of *Plagiophthalmus*.

I would suggest that into this genus of Bell's should be removed, all those species at present included under the genus *Prosopon*, which have "an evenly egg-shaped carapace with the front slightly produced and bent downwards. the surface nearly smooth, and marked by two shallow transverse furrows nearly parallel to each other, the orbits very small, elongate-oval, and placed obliquely within the margin, appearing as if pierced in the substance of the carapace" (Bell, *op. cit.* p. 9).

---

[1] *νέος*, young, in allusion to its size, and also its early appearance in time (and *limulus*); and *falcatus* from the sickle-like form of the body-segments.

Plagiophthalmus, Bell, would thus probably include within it the following species of H. von Meyer's genus *Prosopon*, namely:—

P. hebes, *P. simplex*, *P. rostratum*, *P. spinosum*, *P. elongatum*, *P. depressum*, *P. obtusum*, *P. Stotzingense*, *P. tuberosum*, *P. sublaeve*, *P. laeve*, *P. punctatum*. The following are doubtful: *P. insigne*, *P. æquilatum*, *P. marginatum*, *P. grande*, *P. excisum*, *P. lingulatum*.

For the remainder, the generic name *Prosopon* should be retained, namely: *P. aculeatum*, *P. ornatum*, *P. paradoxum*, *P. torosum*, *P. Heydeni*, and *P. æquum*.

Having only seen actual specimens of a few of these forms I do not wish, at present, to do more than indicate those species, which, I think, will need revision. They all occur merely as detached carapaces, without appendages, and the under-side of the fossil usually adheres firmly to the matrix and is therefore seldom seen.

The crab now to be described (Plate I. Fig. 2), although larger than the Wurtemburg specimens, is no doubt referable to the genus *Prosopon* in its restricted sense.

It was first noticed by Professor Morris, F.G.S., who obtained an imperfect carapace many years since; it was next observed by Mr. Samuel Stutterd, of Banbury, who found a portion of another specimen, which he kindly brought to me for examination. Lastly, for the very perfect carapace, now figured, I am indebted to George Griffith, Esq., M.A., the Assistant-General Secretary of the British Association, who procured it at Stonesfield, from whence the two other examples, above referred to, were also obtained.

The specimen measures fourteen lines in length, and eleven and a half lines in breath.

The front of the carapace is four lines in breadth, and is marked by a semi-circular depression in the centre, and by two laterally diverging horns—similar to those which ornament the front of the carapace in many of the Triangular crabs.[1] Immediately behind these horns are placed the orbits which are bounded on their exterior angles by short blunt spines. Here the carapace measures six lines across; the hepatic region then swells out into a tumid prominence, ornamented by a single spine, the breadth of the carapace being increased to nine and a half lines. Posterior to the hepatic region the cervical or nuchal furrow crosses the carapace, forming a deep indentation between the gastric and cardiac regions. A second transverse furrow, three lines behind the cervical furrow, indents the carapace and unites with the cardiac furrow on either side.

The regions of the carapace are all well-marked and very tumid: the gastric region is the most prominent, and is marked by two mammillæ (which have suggested the trivial name). When viewed in profile (see Pl. I. Fig. 2 *a*) these mammillæ are elevated three and a half lines above the level of the slab on which the carapace rests. The posterior border of the carapace is nine lines in breadth, and but slightly curved. The branchial and cardiac regions of the carapace are covered with minute rounded tubercles. The gastric and hepatic regions are also tuberculated; but the tubercles are fewer and of larger size.

In a paper, communicated to the Geological Society, May 23rd, 1866 (which was published in the Quarterly Journal, vol. xxii. p. 493, pl. xxiv. fig. 1), "On the oldest known British crab (*Palæinachus longipes*) from the Forest Marble of Malmesbury, Wiltshire," I pointed out the synthetic characters which these early forms of Crustacea present. In *Prosopon mammillatum* we have another example of this blending of characters in the outset of the *Brachyura* in Oolitic times.

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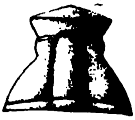
[1] The *Macropodiadæ* of Milne-Edwards.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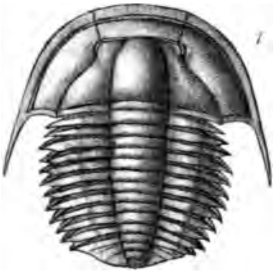
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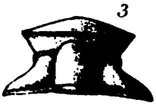
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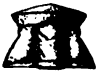
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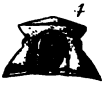
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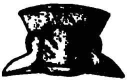
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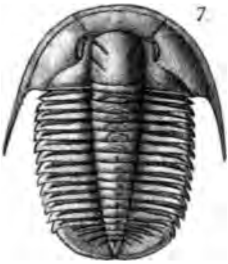
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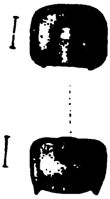
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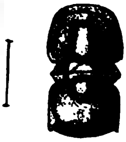
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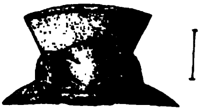
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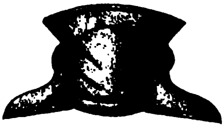
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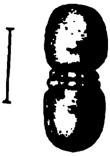
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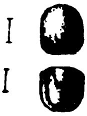
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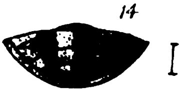
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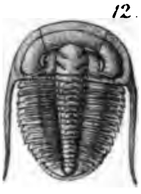
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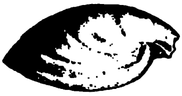
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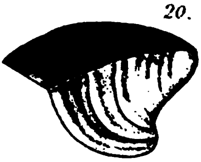
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Tollick del & lith

W West imp

New Trilobites, &c from the Upper Cambrian Rocks of North Wales.

Every systematic naturalist feels it incumbent on him to refer the form he is describing to its proper position in the family and class to which it belongs, but the palæontologist knows well how difficult it is, from a portion only of an animal structure—whether vertebrate or invertebrate—to predicate with certainty its true affinities. In the present case the genus *Prosopon* has been referred to the *Corystidæ*, a group which nearly approaches to the *Anomoura* of Milne-Edwards. Even upon the imperfect knowledge which the present form gives us, we are led to perceive its affinities with the *Anomoura*, and probably when we are in possession of fuller information, we shall be able to refer it with confidence to the *Homoladæ*, a true Anomourous family. In the meantime we must ask our readers to be contented with this brief description, in the hope that more perfect materials may shortly be discovered.

EXPLANATION OF PLATE I., Fig. 2.

Fig. 2. *Prosopon mammillatum*, H. Woodw. Great Oolite, Stonesfield, twice the natural size.

Fig. 2a. Side view of same.

From the cabinet of G. Griffith, Esq., M.A., Harrow.

III.—ON THE "LINGULA FLAGS," OR "FESTINIOG GROUP" OF THE DOLGELLY DISTRICT. PART III.

By THOMAS BELT, F.G.S.

[PLATE II.]

HAVING described in some detail, the rocks of the Maentwrog, Festiniog, and Dolgelly groups, and given a list of the fossils found in each,[1] I shall now make some general remarks upon the fauna. In Part I. I have mentioned that out of all the numerous Trilobites from the Lower Cambrian[2] rocks, only two genera, *Agnostus* and *Conocoryphe*, have been found in higher strata. Strictly speaking, this is only true of *Agnostus*, which passes unchanged in type from the Menevian to the Caradoc strata. On the contrary, the species of *Conocoryphe* from the Lower Cambrian rocks are of essentially different type from those that have been placed in that genus from higher beds. The latter have, I believe, been referred to the genus *Conocoryphe* rather from superficial resemblances than from true affinity.

The possession of facetted or unfacetted pleuræ has been considered of sufficient importance to separate closely allied species into distinct families, and McCoy, in his Classification of the *Trilobita*, has even founded his two main divisions upon that feature. The facetting of the pleuræ may be of generic, but it is not of higher value. The absence of facets to the pleuræ of *Paradoxides* and *Olenus* does not prove, as some palæontologists have supposed, that they were incapable of rolling up. Trilobites with flat pleuræ required no facets to facilitate that operation. It is only when the pleuræ are bent down near the middle that the facets are of use in allowing the ends of the pleuræ to pack in underneath each other.

It is through exaggerating the importance of this feature that some

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[1] See GEOLOGICAL MAGAZINE, 1867, Vol. IV., pp. 493 and 536.

[2] The Lower Cambrian period, according to the classification adopted in this paper is only part of the "Primordial Zone" of Barrande, as that illustrious palæontologist has included in it *Olenus* and *Peltura*, which in reality belong to a second fauna.

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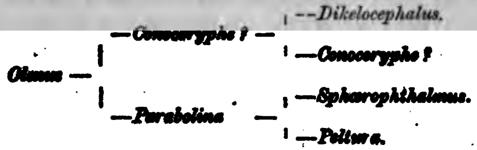
species of Trilobites from the Dolgelly and Tremadoc strata have been separated from the *Olenidæ* to which they naturally belong, and placed with the *Conocephalidæ* with which they have no affinity. These *pseudo-Conocoryphe* have a thin and smooth crust and are flat or but little convex. The pleuræ are falcate and pointed, and only slightly bent down at the fulcrum; the axial furrows are shallow; the facial suture ends below, some distance within the posterior angle. In all these points the *pseudo-Conocoryphe* approach the genus *Olenus*. The typical species of *Conocoryphe* from the Lower Cambrian rocks, on the contrary, are very convex and have a thick, granulated, or even sub-spinous crust. The pleuræ are strongly bent down, so as often to be nearly vertical from the fulcrum; the axial furrows are deep; the facial suture ends below, close to the posterior angle, so that if the marginal furrow of the free cheek were produced downwards it would cut the suture. In all these points the typical *Conocoryphe* are distinct from *Olenus* and approach *Calymene*. All the species of *Conocoryphe* from the Lower Cambrian rocks belong to the typical group, and all the species that have been referred by various authors to that genus from the Upper Cambrian rocks belong to what I have called the *pseudo-Conocoryphe;* I have only retained them provisionally in *Conocoryphe,* because it is impossible without specimens of Angelin's species, or better figures of them than he has given us, to determine whether they belong to his genera *Solenopleura*, *Centropleura*, etc., or not. The whole of these *pseudo-Conocoryphe* show so many points of affinity with *Olenus* that in drawing up the following table of the *Trilobita* from the Maentwrog, Festiniog, and Dolgelly strata, I have had no hesitation in including them amongst the *Olenidæ*.

TRILOBITES OF THE MAENTWROG, FESTINIOG, AND DOLGELLY GROUPS.

Families.	SPECIES.	MAENTWROG BEDS.		FESTINIOG BEDS.		DOLGELLY BEDS.	
		Lower.	Upper.	Lower.	Upper.	Lower.	Upper.
Olenidæ.	*Dikelocephalus ? Celticus*, Sal. ...						—
	„ *? discoidalis*, Sal.						—
	Conocoryphe ? abdita, Sal.						—
	„ *? invita*, Sal.						—
	„ *? Williamsonii*, n. sp.						—
	„ *? longispina*, n. sp....						—
	„ *? bucephala*, n. sp. ...				—		
	Olenus gibbosus, Wahl	—					
	„ *truncatus*, Ang.		—				
	„ *cataractes*, Sal.		—				
	Parabolina spinulosa, Wahl.					—	
	Peltura scarabæoides, Wahl.						—
	Sphærophthalmus humilis, Phil....						—
	„ *bisulcatus*, Phil.						—
Agnostidæ.	*Agnostus nodosus*, Belt	—					
	„ *pisiformis*, Lin.		—				
	„ „ var. *obesus*, Belt.	—					
	„ *sp.*					—	
	„ *obtusus*, n. sp.						—
	„ *princeps*, Sal.						—
	„ *trisectus*, Sal.						—

The lower Cambrian not
defined — a few fossils
before known. cannot define a

The Lower Cambrian rocks, with their most abundant fauna,[1] are followed by strata, containing but two genera of trilobites—*Agnostus* and *Olenus*. Of these, *Agnostus* comes from below and passes on upwards unchanged in type. *Olenus*, on the contrary, only remains true to its typical form through the Maentwrog beds, in which it has three British representatives. In the Upper Festiniog and Lower Dolgelly beds it branches off in two directions. In one, through *Conocoryphe? bucephala* towards the *pseudo-Conocoryphe* and *Dikelocephali* of the Upper Dolgelly beds; in the other, through *Parabolina spinulosa* towards the *Pelturæ* and *Sphærophthalmi* of the same strata. This relation is shown in the following diagram :—



Many links in the chain are wanting, but this much is certain, that the typical *Oleni* of the lower strata are followed by two genera; one of which—*Conocoryphe?*, with entire pygidium and falcate facetted pleuræ, is intermediate between the *Oleni* below and the *Conocoryphe?* and *Dikelocephali* above; the other, *Parabolina* with serrated pygidium and spinous, unfacetted pleuræ, intermediate between the *Oleni* below and the *Sphærophthalmi* and *Pelturæ* above. This result is obtained, not by picking out from a number of species those that could be brought within such a generalization, but by using all the species, and placing them in the order, as to time, in which they occur in the strata.

Some interesting relations between the fauna of the Maentwrog, Festiniog and Dolgelly beds, and that of the underlying Lower Cambrian rocks on the one hand, and of the overlying Tremadoc and Lower Silurian strata on the other, still remain to be pointed out. Between the deposition of the Upper Menevian and the Lower Maentwrog beds, the abundant fauna of the Lower Cambrian period disappears, and our next horizon shows only a few species of *Agnostus* and *Olenus*; the latter, pigmy representatives of the giant *Paradoxides* of the preceding age. All on through the Maentwrog, Festiniog, and Dolgelly epochs, the various Trilobites that successively appear either belong to or are closely allied to these two genera. The fauna is a compact and homogeneous one. We have no intrusions of new types of structure, but the more recent forms are, if I may use the phrase, the natural evolution of the older. When we pass on upwards into the Tremadoc and Arenig epochs, a great and apparently sudden change takes place.

Large Trilobites belonging to the *Asaphidæ* now first appear, and then the *Cheiruridæ, Trinucleidæ*, and *Calymenidæ* come upon the stage. Of these there has been no development in the area under consideration. They come in like an invading host, and the few species of *Olenidæ* and *Agnostidæ* that struggle on upwards are outnumbered, and, as it were, crowded out, by the intruders. It is an interesting inquiry—from whence did the latter come? but our materials are too scanty to furnish a reply. It is, however, to be noted, that at least two of the Lower Cambrian genera which are entirely absent throughout the Maentwrog, Festiniog, and Dolgelly groups are represented in the Tremadoc and Arenig strata by two families, greatly modified it is true, but yet showing many points of structural affinity with the much more ancient genera. *Microdiscus*, so abundant in the Menevian beds, comes back to us after a long absence in the *Trinucleidæ* of the Tremadoc and Arenig groups; and the Menevian *Conocoryphe* are represented by the *Calymenidæ* of the Arenig and higher rocks, and are likewise absent from the intermediate strata.

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[1] See *ante*, Part I., "Table of the Cambrian Rocks showing the range of the Genera," Vol. IV. p. 495.

I think that it is not improbable that in the Tremadoc epoch we behold the return of a fauna driven from our area at the close of the Lower Cambrian period, and which has, in the meantime, been greatly developed, so far as the Trilobita are concerned, in some other area. This supposition would be a hazardous one to propound on the evidence of the Trilobites alone, but it is rendered more feasible by a study of the lower forms of life that accompany them. The sea towards the close of the Lower Cambrian period must have teemed with life. Besides the various genera of Trilobites, Pteropodous *Thecæ* must have swarmed, along with species of *Lingulella, Obolella. Discina,* and *Protospongia.* When the Trilobites disappear, these lower organisms disappear also. A few specimens of *Lingulella* have, it is true, been found in the Maentwrog beds, but they belong to a different type from the Lower Cambrian species, and *Theca, Obolella, Discina,* and *Protospongia* are unknown. In the Festiniog beds, one, and perhaps two, species of *Lingulella* abound, but they are of the same type as the Maentwrog species, and the other genera are still absent. In the Dolgelly beds we have the rare occurrence of *Obolella,* and a single specimen of *Protospongia* has been found in a loose stone, believed to be from these strata. The *Lingulella* are still of a different type from the Lower Cambrian forms, and not a trace of *Theca* nor *Discina* have occurred. When, however, we pass into the Lower Tremadoc strata, all the lower types of life present in the Lower Cambrian rocks come back to our area, almost unchanged specifically. *Thecæ* resembling the Lower Cambrian forms again abound, along with species of *Obolella, Lingulella, Discina,* and *Protospongia,* so like the Lower Cambrian species that I doubt whether they can be distinguished from them. When I first found this Lower Tremadoc fauna upon the flanks of Mynydd Gader, near Dolgelly, I doubted whether I had not come upon Menevian strata, brought in by some great fault, so similar were the lower forms of life; and it was only the presence of *Niobe Homfrayi,* and *Asaphus innotatus,* that assured me that the rocks were really of Lower Tremadoc age. *Lingulella ferruginea, Obolella maculata, Discina labiosa, Protospongia fenestrata,* and

P. flabella, have almost their exact counterparts in the Lower Tremadoc rocks of Dolgelly, although, as I have already shown, there are 5,000 feet of strata lying between, occupied by an entirely distinct fauna.

When examining the nearly barren strata of the Maentwrog epoch, I have sometimes speculated on the cause of the poverty of its fauna. It was not on account of the nearness to the beginning of life on our globe, for in older rocks still, a varied fauna abounded. It could scarcely arise from conditions of sea bottom, for thick alternations of sand, with fine grained sediments, bespoke varied depths of water under which they had been deposited. The blue beds of the Maentwrog strata do not differ lithologically from the blue beds of the Menevian group. Might there not be in these ancient epochs great oscillations of climate, such as we have certain proofs of in more recent times? Was it the advent of a cold period that drove southwards the Lower Cambrian fauna, excepting a few modified forms fitted to thrive in a more rigorous climate? and was it the return of a warmer climate in the Tremadoc epoch that brought back the ancient types of life more or less changed?

NOTES ON THE SPECIES.

Conocoryphe? Williamsonii, spec. nov. (Pl. II. Figs. 7-11.)—Length 1½–2½ in., breadth ⅚-1⅓ in. Ovate oblong.

Head, broadly semi-circular, with short strong spines pointing downwards and outwards. Glabella, a truncated cone, with two pairs of oblique furrows. Eyes small, joined to the glabella by short prominent ocular ridges, and distant from it about one-half its width. Frontal limb moderate, with a narrow margin. Fixed cheeks, curving out below the eye. Free cheeks, broad, with a scarcely impressed margin.

Thorax of 14 rings. Axis tapering, depressed. Pleuræ, flat, first two, pointed and strongly facetted, the remainder falcate and very slightly facetted.

Pygidium of 4 axial rings, of which the last is pointed and ends in a narrow ridge, running out to the margin of the limb. Limb rounded and slightly retuse, with about four furrows. Margin depressed, broad next the pleuræ and tapering to where it meets the ridge from the last axial ring.

The head of this species somewhat resembles *C. depressa*, Salter, but is easily distinguished from it by the deep glabella furrows, falcate pleuræ and truncate, slightly retuse tail. I know of no other species with which to compare it.

I have great pleasure in dedicating this fine species to my friend Mr. Ezekiel Williamson, in whose company it was first found by myself in 1865, in the black shales of the Upper Dolgelly beds, near Rhiw-felyn.

Conocoryphe? longispina, spec. nov. (Pl. II. Figs. 12-14.—Length ¾ in., breadth ½ in. Ovate.

Head.—Head semi-circular, with long, slightly curved spines, reaching beyond the tail. Glabella oblong, truncate, about as broad as long, with two pairs of deep, oblique furrows, of which the lowest is most oblique, and reaches nearly to the neck furrow. Eyes large, connected to the glabella by prominent ocular ridges, and distant from it rather less than one-half its width. Frontal limb broad, with a lineated margin. Fixed cheeks, minute. Free cheeks broad, with a lineated margin.

Thorax of 14 rings. Axis regularly tapering. Axial rings, with a small tubercle at each end, and traces of a central tubercle, which are more prominent on the lower rings. Upper pleuræ pointed, strongly facetted; middle pleuræ falcate, moderately facetted, lower pleuræ truncate, slightly facetted: all bent down at less than one-half their length from the axis.

Pygidium sub-rotund, of three axial rings. Limb, with three furrows. Margin narrow, linear.

This species is easily distinguished by its long head spines; short, broad glabella; long eyes and broad frontal margin. It occurs sparingly along with the last in the Upper Dolgelly beds, near Rhiw-felyn, where I discovered it in 1865.

Conocoryphe ? bucephala, spec. nov. (Pl. II. Fig. 1–6). Length 1⅜ in. Breadth 1 in. Ovate.

Head broadly semi-circular with strong spines pointing downwards and a little outwards. Glabella subconical, truncated, very prominent, and without furrows when perfect, Figs. 1 and 2; but when crushed Fig. 3, or divested of outer crust Figs. 4 and 5, showing two pairs of internal ones of which the upper is short and the lower long and very oblique, reaching nearly to the neck furrow. Some specimens show a third short pair of furrows near the apex of the glabella. Eyes small and prominent, distant from the glabella about half its width and joined to it by ocular ridges that are nearly obsolete in perfect specimens of the head, but clearly shown in crushed ones. Frontal limb narrow, with a strong triangular margin marked off by a deep groove. Cheeks broad, prominently convex, with a wide margin.

Thorax of 14 (?) rings. Axis convex, tapering. Pleuræ falcate, pointed strongly, grooved, and facetted. Fulcrum of the pleuræ prominent, less than half their length distant from the axis. (See Pl. II. Fig. 6.)

Pygidium not preserved in any of the specimens, but it must have been small and of not more than one or two rings.

The specimens of this species when perfect have all their parts prominent and convex. The head is large and resembles *C. ? depressa*, Sal., and that species also when uncrushed shows no glabella furrows, in which condition it is *C. ? verisimilis*, Sal., and probably also *C. ? vexata*, of the same author. Specimens of *C. ? bucephala*, flattened by pressure, resemble *Olenus micrurus*, Salter, to which species I was at one time inclined to refer it, but an examination of the specimens of *O. micrurus*, from near Trawsfynydd, in the Museum of Practical Geology, has convinced me that it is a true *Olenus* and quite distinct from *C. ? bucephala*. *C. ? bucephala* is not uncommon at Gwern-y-barcud, near Penmaen-pool; on Mynydd Gader, and near Craig-y-Dinas, along with *Hymenocaris vermicauda*, *Bellerophon Cambriensis*, and a small *Lingula* in Upper Festiniog beds.

Sphærophthalmus bisulcatus, Phil.; syn., *Olenus bisulcatus*, Phil. *Olenus* (*Spærophthalmus*) *pecten*, Salter. *Olenus* (*Sphæroph.*) *flagellifer*, Sal. *Olenus alatus*, Sal.

I have examined the specimens in the Museum of Practical Geology, on which the above species were founded. They are fragments only, variously distorted. When they are studied in connection with the perfect specimens that we have now obtained from the Dolgelly district there can, I think, be no doubt of their being one and the same species. I think the species cannot be referred to *Olenus (Sphær.) alatus*, Bœck, unless we assume a large amount of error in Angelin's figure of that species, as he shows the pygidium entire and with four axial rings, whereas *Sph. bisulcatus* has a minute serrated pygidium of two rings only, and is furnished with a long terminal spine. Some fragments of *Sphæroph. alatus*, Bœck, in the Museum of the Geological Society resemble *Sphæroph. humilis*, Phil., but that species also has a minute pygidium with a long terminal spine. At the same time I think it highly probable, that when we are able to compare our Cambrian trilobites with specimens of the Scandinavian species, many of our names will have to give place to those of Angelin, though we cannot at present identify them by the figures he has given us.

Mr. E. Williamson discovered this species in the black shales at Rhiw-felyn in 1865. More recently, Mr. J. C. Barlow found it in great profusion within a few yards of the first discovery. A band of about three inches thick of the shale, is almost entirely composed of the remains of *S. bisulcatus*, along with a few specimens of *S. humilis*.

Agnostus obtusus, spec. nov. (Pl. II. Figs. 15, 16). Length ¼in., breadth ⅙in. Oblong, obtuse.

Head, a truncated semi-circle. Glabella five-eighths length of head, ovate, obtuse, with a nearly obsolete central tubercle, and traces of a nearly obsolete furrow, separating a terminal lobe. Two minute triangular lobes at base of glabella. Limb nearly of equal width all round. Margin narrow.

Thorax, of two rings. Axis, broad.

Pygidium, shaped like head. Axis, short, pentangular, one-third the length of the pygidium, with a nearly obsolete tubercle, near the end. Limb narrow at the sides, and broad at the end of the axis. Margin marked off by a deep groove, and widened near the lower angles, where it has a short spine on each side.

This species belongs to the same group as *A. tardus*, Bar., *A. lentiformis*, Ang., and *A. trinodus*, Sal., from all of which it differs in the much shorter and unlobed axis of the pygidium. In the Upper Dolgelly beds at Rhiw-felyn, I have found this species very sparingly, along with *A. trisectus*, *A. princeps*, and the other fossils of the black shales.

Agnostus trisectus, Salter.

This species, described from imperfect specimens of the pygidium, occurs in great abundance in the black shales at Rhiw-felyn, where I have obtained numerous perfect specimens, a complete series of which is now deposited in the British Museum. These show that, like *A. princeps*, it was furnished with marginal spines to the pygidium; and other close resemblances make it most difficult to distinguish some of the specimens from that species, with which, however, I hesitate at present to join it, especially as the able author of the Monograph on the Trilobita has announced his intention of dealing with the *Agnostidæ*, in the next part of that valuable work.

Agnostus Barlowii, spec. nov. (Pl. II. Figs. 17, 18).—Length $\frac{1}{3}$in., breadth $\frac{1}{7}$in. Oblong, ovate.

Head rounded, ovate, plain, rising from all sides to a point near the base, Margin very narrow.

Thorax of two rings. Axis trilobate.

Pygidium, shaped like head, rising to a central point near the base, with two slight indentations, marking the commencement of an obsolete axis.

This species resembles Angelin's figures of his *A. glandiformis* and *A. bituberculatus*, but differs in the absence of tubercules, and in its trilobate thoracic axis. To *A. nudus*, Bar., it comes still nearer, but that species has neither the axial furrows of the pygidium, nor the trilobate thoracic axis of *A. Barlowii*.

It is a striking example of the persistence of type amongst the *Agnostidæ*, that the nearest known ally of *A. Barlowii*, which is a Tremadoc form, should be a species from the Lower Cambrian rocks of Bohemia.

It occurs in the Lower Tremadoc beds near Rhiw-felyn, along with *Asaphus innotatus*, *Niobe Homfrayi*, *Conocoryphe? depressa*, etc., where it was first found by Mr. J. C. Barlow, of Birmingham. This species comes from rocks a little beyond the limits of this paper, but I include it, as it is the first example of *Agnostus* from British Tremadoc strata, and for the purpose of commemmorating the services of Mr. J. C. Barlow, in elucidating the geology of the Dolgelly district.

Bellerophon Cambriensis, spec. nov. (Pl. II. Figs. 19, 20.)

Broadly involute with three or four distant, coarse ridges of growth, crossed by faint longitudinal striæ; keel narrow.

The discovery of this species carries the range of the Heteropodous Mollusca much lower down in the Cambrian rocks than was before known. I first found it near Craig-y-dinas, but have since discovered that it is not uncommon along with *Conocoryphe? bucephala* and *Hymenocaris vermicauda*, wherever the Upper Festiniog rocks are exposed as on Mynydd-gader, and at Gwern-y-barcud, near Penmaen-pool.

EXPLANATION OF PLATE II.

Figs. 1-6. *Conocoryphe? bucephala*, spec. nov., from specimens in British Museum and collection of Thos. Belt.

„ 7-11. *Conocoryphe? Williamsonii*, spec. nov., from specimens in British Museum and collection of Thos. Belt.

„ 12-14. *Conocoryphe? longispina*, spec. nov., from specimens in British Museum and Museum Practical Geology.

„ 15, 16. *Agnostus obtusus*, spec. nov., from specimens in British Museum.

„ 17, 18. *Agnostus Barlowii*, spec. nov., from specimens in British Museum and collection of Mr. J. C. Barlow, of Birmingham.

„ 19, 20. *Bellerophon Cambriensis*, spec. nov. Both specimens figured are on one slab in British Museum.

ERRATA.

In Part I., page 495. Table of the Cambrian rocks. *Obolella* should have been marked present in the upper part of the Dolgelly group and lower part of the Tremadoc group, and *Discina* in the lower part of the Tremadoc group.

In Part II., page 540, line 18 from the bottom, for *Conocoryphe micrura*, Sal., read *Conocoryphe? bucephala*, spec. nov.

IV.—On Brecciated Concretions.

By John Ruskin, Esq., F.G.S.

(Continued from the November Number, p. 483.)

(PLATE III.)

THE states of semi-crystalline silica are so various, and so co nected in their variety, that the best recent authorities ha been content to group them all with quartz, giving to each only few words of special notice; even the important chapters of Bisch describe rather their states of decomposition and transition than t minerals themselves. Nevertheless, as central types, five conditio of silica are definable, structurally, if not chemically, distinct; a forming true species: and in entering on any detailed examinati of agatescent arrangements, it is quite necessary to define with pr cision these typical substances, and their relation to crystalline quar

I. *Jasper.*—Opaque, with dull earthy fracture; and hard enou to take a perfect polish. When the fracture is conchoidal the mine is not jasper, but stained flint. The transitional states are confus in fracture; but true jasper is absolutely separated from flint by t structural characters; on a small scale it is capable of the m delicate pisolitic arrangement; and on a larger scale is continual found in flame-like concretions, beautifully involved and contorte But flint is never pisolitic, and, in any fine manner, never coiled; n do either of these structures take place in any transitional specime until the conchoidal fracture of the flint has given place to the d earthy one of jasper; nor is even jasper itself pisolitic on the fractu being too close-grained. The green base of heliotrope, with a pe fectly even fracture, may be often seen, where it is speckled wi white, to be arranged in exquisitely sharp and minute spherical co cretions, cemented by a white paste, of which portions sometim take a completely brecciated aspect, ea fragment being outlined by concave se ments of circles (Fig. 1). Jasper is em nently retractile, like the clay in septari and in agates often breaks into warp fragments, dragging the rest of the sto into distortion. In general, the imbedd fragments in any brecciated agate will mainly of jasper; the cement, chalcedonic, or quartzose.

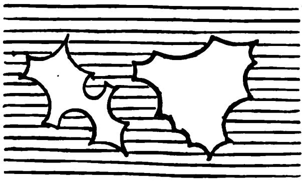


Fig. 1.

II. *Flint.*—Amorphous silica, translucent on the edges, with fi conchoidal fracture. Opaque only when altered, nascent, or staine Never coiled, never pisolitic, never reniform; these essentially n gative characters belonging to it as being usually formed by a slo accumulative secretion, and afterwards remaining unmodified (pr serving therefore casts of organic forms with great precision). It less retractile than jasper; its brecciate conditions being not so mu produced by contraction or secession, as by true secretion, even wh most irregular in shape (as a row of flints in chalk differ from t limestone fragments represented in Vol. IV. Plate XX. Fig. 3, whi might stand for a jasperine structure also). But there are innume able transitions between these two states, affected also by extern

Geol: Mag. 1868. Vol. V. Pl. III.

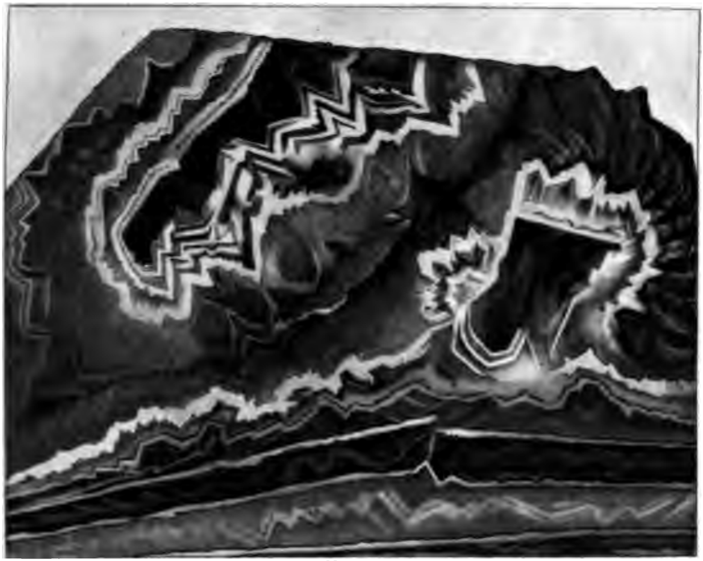


Fig 1.

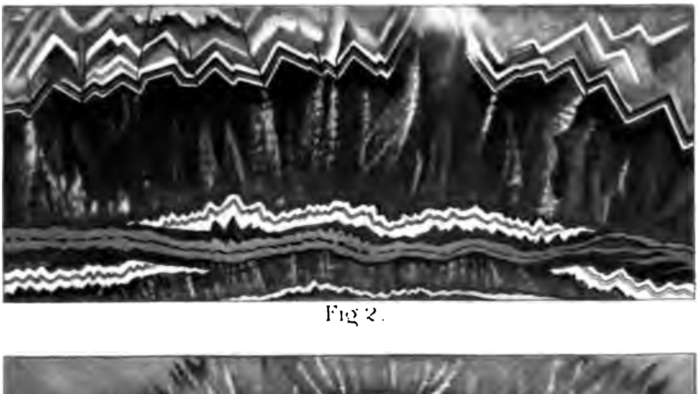
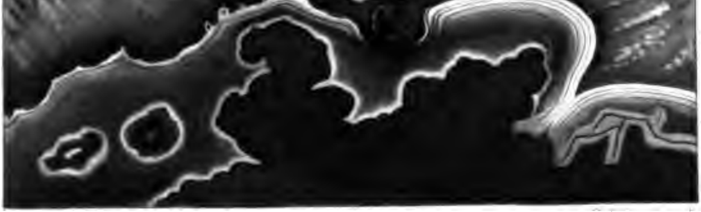


Fig 2.



[illegible] Fig 3. [illegible]

AMETHYST QUARTZ.

with warped Faults in concretion

violence, which we shall have to examine carefully. Within these nodular concretions, flint is capable of a subsequently banded, though not pisolitic arrangement. (See Dr. S. P. Woodward's paper on banded flints, in this MAGAZINE, Vol. I. for October, 1864, p. 145.)

III. *Chalcedony.*—Reniform silica, translucent when pure, opaque only when stained, nascent, or passing into quartz. The essential characteristic of chalcedony is its reniform structure, which in the pure mineral is as definite as in wavellite or hæmatite, though when it is rapidly cooled or congealed from its nascent state of fluent jelly it may remain as a mere amorphous coating of other substances; very rarely, however, without some slight evidence of its own reniform crystallization. The study of its different degrees of congelation in agates is of extreme intricacy. As a free mineral in open cavities it is actively stalactitic, not merely pendant or accumulative, but animated by a kind of crystalline spinal energy, which gives to its processes something of the arbitrary arrangement of real crystals, modified always by cohesion, gravity, and (presumably) by fluid and gaseous currents.

There is no transition between chalcedony and flint. They may be intimately mixed at their edges, but the limit is definite. Impure brown and amber-coloured chalcedonies, and those charged with great quantities of foreign matter, may closely resemble flint, but the two substances are entirely distinct. Between jasper and chalcedony the separation is still more definite in mass, jasper being never reniform, and differing greatly in fracture; but the flame-like or spotted crimson stains of chalcedony often approach conditions of jasper; and there is, I suppose, no pisolitic formation of any substance without some inherent radiation, which associates it with reniform groups, so that pisolitic jasper must be considered as partly transitive to chalcedony. On the other hand chalcedony seems to pass into common crystalline quartz through milky stellate quartz, associated in Auvergne with guttate and hemispherical forms.

IV. *Opal.*—Amorphous translucent silica, with resinous fracture, and essential water. Distinguished from chalcedony by three great structural characteristics: *a*, its resinous fracture; *b*, that it is never pisolitic or reniform; *c*, that when zoned, in cavities or veins, its *zones are always rectilinear*, and transverse to the vein, while those of chalcedony are usually undulating, and parallel to the sides of the vein; level only in lakes at the bottom of cavities.

V. *Hyalite.*—Amorphous transparent silica, with vitreous fracture, and essential water. Never reniform, nor pisolitic, nor banded; but composed of irregularly grouped bosses, generally elliptical or pear-shaped (only accidentally spherical), formed apparently by successive accretion of coats, but not showing banded structure internally (Fig. 2). Entirely transparent, with splendid smooth glassy fracture. Sometimes coating lava; sometimes in irregularly isolated patches upon it: apparently connected in structure with the roseate clusters of

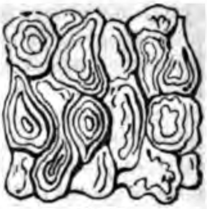


Fig. 2.

milky chalcedony of Auvergne. I shall keep the term "guttate" for this particular structure, of which singular varieties also occur among the hornstones of Cornwall.

These five main groups are thus definable without embarrassment: two other conditions of silica, perhaps, ought to be separately named; namely, cacholony, which seems to take a place between chalcedony and opal, but which I have not yet been able satisfactorily to define; the other, the calcareous-looking, usually whitish agate, which often surrounds true translucent agate, as if derived from it by decomposition. I am under the impression that this is chalcedony, more or less charged with carbonate of lime, and that it might be arranged separately as lime-jasper, differing from aluminous jasper by being capable of reniform structure; but it is certainly in some cases an altered state of chalcedony, which seems in its more opaque zones to get whiter by exposure to light. I shall therefore call it white agate, when it harmoniously follows the translucent zones; reserving the term jasper for granular aggregations. Perhaps ultimately it may be found that nascent chalcedony can take up either oxide of iron, or alumina, or lime, and might relatively be called iron-jasper, clay-jasper, and lime-jasper; but for any present descriptive purpose the simpler arrangement will suffice.

These, then, being the principal types of agatescent silica, it is of importance to define clearly the two structures I have severally called pisolitic and reniform.

A pisolitic mineral is one which has a tendency to separate by spherical fissures, or collect itself by spherical bands, round a central point.

A reniform mineral is one which crystallizes in radiation from a central point, terminating all its crystals by an external spherical surface. It is, however, difficult to define this character mathematically. On the one hand, radiate crystals may be terminated by spherical curves, as in many zeolites, without being close set enough to constitute a reniform mass; on the other, radiate crystals, set close, may be terminated so as to prevent smoothness of external spherical surface, and I am not sure whether this smoothness is a mere character of minute scale (so that chalcedony, seen delicately enough, might present pyramidal extremities of its fibres on the apparently smooth surface), or whether, in true reniform structure, the crystallization is actually arrested by a horizontal plane: I do not mean a cystalline plane, as in beryl, but one of imperfect crystallization, presenting itself only under a peculiar law of increase. Thus, in hæmatite, which is both reniform and pisolitic, the masses often divide in their interior by surfaces of jagged crystallization, while externally they are smooth and even lustrous; but I put this point aside for future enquiry, because it will require us to go into the methods of possible increment in quartz-crystals, and for our present purpose, we need only a clear understanding of two plainly visible conditions of jasper and chalcedony, namely, that jasper will collect itself pisolitically, out of an amorphous mass, into concretion round central points, but not actively terminate its external surface by spherical curves; while chalcedony will energetically so terminate itself externally, but will, in ordinary cases, only develope its pisolitic structure subordinately, by forming parallel bands round any rough surface it has to cover, without collecting into spheres, unless either provoked to do so by the introduction of a foreign substance, or encouraged to do so by accidentally favourable conditions of repose. And here branch out for us two questions, both most intricate; first, as to the introduction of foreign bodies; secondly, as to the crystalline disposition of chalcedony, under variable permission of repose.

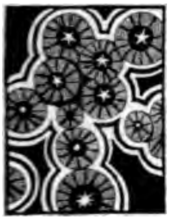


Fig. 3.

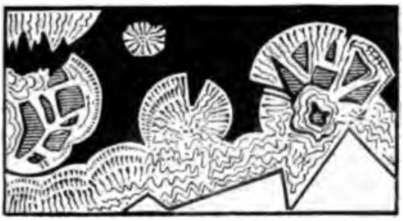


Fig. 4.

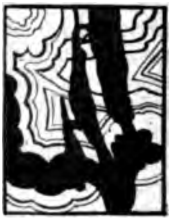


Fig. 5.

First—As to foreign substances. I assume that in true pisolitic concretion, such as that of the jasper, roughly sketched in Fig. 3. (it is not a coral—the radiant lines are merely conventional indications of the grain of the jasper, so far as it is visible with a lens[1]), no foreign body has provoked the orbicular arrangement. The jasper is red; the little dark circles are wells of pure chalcedony, each containing within it a white ball of crystallized quartz, forming a star on the section. The whole is magnified about three times in the drawing, being a portion of a horizontal layer, alternating with solid white jasper. It seems that the pisolitic structure is here truly native; but we must nevertheless grant the possibility that the balls of quartz may have had some organic atom for their nucleus. On the other hand, in the ordinary conditions of dendritic agate, in which stalactites of chalcedony surround branches of clearly visible chlorite,[2] or of oxide of iron or manganese, I assume that in the plurality of cases, such sustaining substances have been first developed, and the chalcedonic stalactite afterwards superimposed, being, in the most literal sense of the word, "superfluous" silica; but I, nevertheless, see great reason for thinking that, in many cases, the core of the group is only a determination to its centre of elements which had been dispersed through the mass. In the generality of Mocha-stones, the dendritic oxides, so far from being an original framework, are clearly of subsequent introduction, radically following the course of fissures from which they float partially into the body of the imperfectly congealed gelatinous mass; in other more rare, and singularly beautiful cases, the metallic oxides ramify in curves in the intervals of the pisolitic belts, and then there is nearly always a dark rod in the stalactitic centre, which may or may not be solid. In the finest Mocha stones, I think it is a black film round a chalcedonic nucleus; but in the associations of limonite with chalcedony, it is usually of solid radiate iron-oxide, and doubtless of prior, though perhaps only of immediately prior, formation. A more complex state is presented by such stalactites, when enveloped in a chalcedonic solid paste, to which they do not communicate their own zoned structure. Ordinarily, the surrounding mass throws itself into zones parallel with those of the enclosed stalactite; but, in some cases, it is of quite adverse structure, perhaps laid level across the stalactitic fall.

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[1] In my woodcut diagrams I shall employ no fine execution; they will be merely illustrative, not imitative,—diagrams, not drawings. In the plates, on the contrary, with Mr. Allen's good help, I shall do the best I can.

[2] Or green earth? I cannot find any good account of the green substance which plays so important a part in the exterior coats of agates, and Iceland chalcedonies.

The conditions admitting the interfusion of this solid paste, are strangely connected with those which cause chalcedony to form true vertical stalactites and straight rods, instead of arborescent and twisted stalactites. I have never seen the twisted stalactite unless enveloping fibres of some foreign, perhaps organic, substance, enclosed in massive chalcedony; but the straight stalactite is perhaps oftener so than free (unless connected with limonite). and it would appear, therefore, as if the apparently interposed mass were really of contemporary formation. or else it would sometimes enclose the contorted stalactite. But this question respecting the causes of the vertical and twisted groups properly belongs to the second branch of our inquiry as to states of repose.

Second: Conditions affecting mode of crystallization. It is evident that fluent deposits of silica contained in a rock-cavity must be affected, in course of their solidification, not only by every addition to their own mass, but by every change in the temperature or grain of the surrounding rock, so that we have innumerable modifications of state, dependent partly on accession and transmission of substance, partly on changes in external temperature and pressure. And, under these influences, we perceive that the gelatinous silica occasionally obeys gravity,[1] and occasionally resists it, becoming sometimes pendent from the roof, and forming level lakes on the floor of cavities; at other times, throwing parallel bands on floor and roof alike, and in transitional periods, forming thick layers on the floor, and thin ones at the sides, the layers being liable, meantime, to different degrees of compression from their own modes of solidification, which give them, locally, the appearance of an elastic compression and expansion: there seems no limit to the fineness of their lines at these compressed points, when their continuity is uninterrupted. Figures 6 and 7 illustrate, in two small pieces of agate, each here magnified about three times, most of the appearances which must be severally studied. In Fig. 6 the lowest band, A. level at the bottom, broken irregularly towards the rough side of the stone, is yet of nearly even thickness everywhere; above it, the one with a black central line encompasses the whole agate symmetrically. Then a white band, thin at the bottom, projects into concretions on the flanks. Then, a thick white deposit, B. does not ascend at the flank at all; then a crystalline bed, with pisolitic concretions at the bottom of it, changes into dark chalcedony (drawn as black), which ascends at the flanks. Then another thin line at the bottom, in concretion at flanks; then one thick at the bottom, thin at the flanks, and so upwards. In Fig. 7, a level mass, itself composed of silica in two different states, one separating into flakes, and the other even-laid, is surrounded by bands which melt into it with gradually diminishing thickness, these being evidently subordinate to an external formation of crystalline quartz; the whole terminated by a series of fine bands of graduated thickness, and by clear chalcedony (drawn as black).

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[1] I use this word gravity in some doubt; not being quite sure that the straight beds are always horizontal, or always inferior to the rest deposited at the same time. I have one specimen in which, according to all analogies of structure, it would appear that the vacant space is *under* the level floor, between it and reniform chalcedony; and sometimes these floors cross pillars of stalactite like tiers of scaffolding.

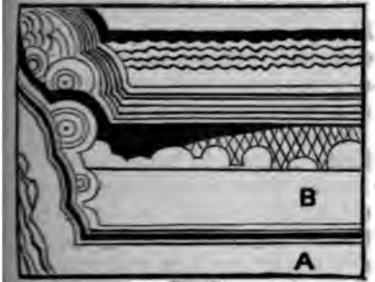

Fig. 6.

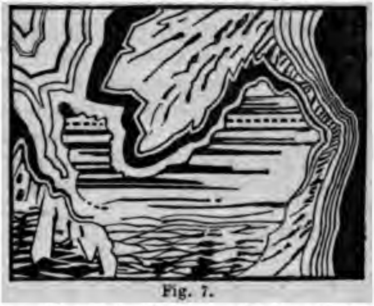

Fig. 7.

Now all these, and many more such variations, take place without any apparent disturbance of the general mass, each bed conforming itself perfectly to the caprice of its neighbour, and leaving no rents nor flaws. But an entirely different series of phenomena arise out of the fracture or distortion of one deposit by another, after the first has attained consistence. Thus, in Fig. 4, a yellow orbicular jasper is split into segments, singularly stellate, or wheel-like, and then variously lifted and torn by superimposed chalcedony; and in Fig. 5, a white and opaque agatescent mass is rent, while still ductile, the rents being filled with pure chalcedony: and from this state, in which the pieces are hardly separate, and almost hang together by connecting threads, we may pass on through every phase of dislocation to perfect breccia; but, all the while, we shall find the aspect of each formation modified by another kind of fault, which has no violent origin, and for the illustration of which I have prepared Plate III. This plate represents (all the figures being of the natural size) three sections of amethystine agate, in which the principal material is amethyst-quartz, and the white jasperine bands for the most part form between the points of the crystals.

All the three examples are types of pure concrete agatescence in repose, showing no trace whatever of external disturbance. The fault in the inclined bed at the base of the uppermost figure, has some appearance of having been caused by a shock; but for that reason is all the more remarkable, the bed beneath it being wholly undisturbed, and its own fracture quite structural, and connected with the crystalline elevation and starry concretion above. I have no idea at present why the central portions of these concretions of dark amethyst are partly terminated by right lines, or what determines the greater number of bands on one side than on the other.

The second figure is of a less varied, but of still more curious interest. There is no trace of violence or fracture in the stone, and the line of the crystallized amethystine mass is undisturbed at the summits, except by a partial dissolution in one part and mingling with the white bands above. But the white undulatory band at its base is cut into three parts, and the intermediate portion lifted (or the flanks removed downwards), a quarter of an inch, by pure calm crystalline action, giving thus room for an interferent brown vein of less definite substance which proceeds without interruption, dividing the white band in a direction peculiarly difficult to explain, unless by supposing the interferent one to be the slow filling of a fissure originally opened in the direction of the black line in Fig. 8, and straightened in widening.

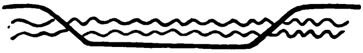

Fig. 8.

But the third example is inexplicable, by any such supposition. It is the agatescent centre of a large amethyst nodule, in which a small portion, about the third of an inch long and a quarter of an inch thick, of its encompassing belt, is separated bodily from the rest, taken up into the surrounding concretion of quartz, and its place supplied by a confused segregation of chalcedony, with a sprinkled deposit of jasper spots on the surface exposed by this removal of its protecting coat; spots, which in the rest of the stone, form on the exterior of the coat itself, just under the quartz. There are many points in all these three examples which it is useless to take further note of at present, but to which I shall return, after collecting examples enough to form some basis of reasoning and comparison. I must apologize, as it is, for the length of this paper on a subject partly familiar, partly trivial, yet in which these definitions, not by skill of mine expressible in less room, were necessary before I could proceed intelligibly.

V.—Notes of the Weathering of Rocks near the Sea.

By G. Henry Kinahan, F.R.G.S.I., Etc.

THE following notes on the Weathering of Rocks near the Sea, culled from my note-books, appear to be facts unobserved by the various writers on subaërial denudation. Those agents would seem to act differently near the sea than away from it, not only in the quantity of the work done but also on the colouring matter in the rocks.

As to colour, I find—"In the neighbourhood of Valencia, Co Kerry, the weather seems to have mostly affected the red colouring matter in the rocks for those of a purple colour, weather a whitish blue, while those of a green colour only become brighter; inland, the purple rocks are weathered red, and the green yellow; so that, there

e weather seems to have the power of removing the blue part of e colouring matter." In my notes on the rocks of the Co. Galway, find : "The original colour of the Felsite associated with the granite 1 the north of Galway Bay seems to be a purplish green or grey, ut at the coast they weather red, while inland they weather a ellowish or dirty white."

On the disintegration of rocks has been noted—"At the sea-shore outh of Baltimore, Co. Cork, the slates immediately above the inuence of the waves have by the weathering out of their slaty leavage become so rugged and sharp that they can be compared to othing but knives placed side by side with their edges looking upards ; this appears to be remarkable, for if these rocks are followed nly a little inland, they seem scarcely weathered as the ice striæ are uite perfect on them." "The slates composing the Little Skellig, ff the coast of Kerry, are weathered along the nearly vertical cleavge planes, giving them a sharp serrated surface, while similar rocks n the main land only a little removed from the sea-coast are scarcely eathered."

"On the Aran Islands, Galway Bay, the subaërial agencies seem o denude the limestones quicker than on the mainland, for on those slands the perched blocks having protected the portion immediately nder them, now stand on pedestals from four to six inches high, while inland, the pedestals under the blocks rarely exceed four nches, and generally their average is about two inches and a-half."

"The veins of Eurite that traverse the Granites on the north of alway Bay, are scarcely affected by the weather, and thereby give record of the amount of waste the mass of the granite rocks have ndergone since the ice disappeared from that country. From them t would also appear that the granites disintegrate more freely near he sea than away from it ; for inland these veins stand from half n inch to two inches above the mass of the rock, while near the ea they have been remarked as much as three and a-half inches, nd rarely, if ever, are less than an inch and a-half; moreover in ome places near the sea, even the Eurite veins are weathered."

NOTICES OF MEMOIRS.

I.—ON DENUDATION IN SCOTLAND SINCE GLACIAL TIMES.

By JAMES GEIKIE, ESQ., of the Geological Survey of Scotland.

[Being the substance of a paper read before the Geological Society of Glasgow, 28th November, 1867.]

MR. JAMES GEIKIE began by remarking that, throughout the wide domain of Geological inquiry, there was perhaps no subject of which it was easier to gain some idea, and yet, at the same time, more difficult to acquire an adequate conception, than denudation. We all know how rains and frosts and chemical decomposition were employed unceasingly in modifying the aspect of hills and plains,—how rivers were ever deepening and widening the valleys in which they flowed—how the sea, by its constant wave-action, aided by frosts and other agencies, tended to reduce to its own level the solid lands, with all their infinite variety of outline. It was no less generally known how the Geological structure of a country must always influence its configuration—how the softer rocks would generally lie in the valleys, and those of a more durable nature occupy the heights—how the contour of the heights would vary according as these were formed of schists of granite, of dolerite, of quartz-rock, or of any other well-marked species—and how this peculiar character was due to the unequal manner in which the different masses yielded to the touch of the atmospheric forces, so that a trained eye could oftentimes detect at a considerable distance the nature of the rocks by reference to the aspect of the hills alone. But while all were willing to admit that the subaërial agents might do something towards modifying the surface of a country, yet many would not allow that its straths and valleys had been mainly formed by these seemingly feeble forces. Nor when we reflected on the enormous time required by the hypothesis which they rejected, could it be wondered at that some geologists, whose chief stumbling-block was *time*, should have summoned up subterranean action to account for certain appearances connected with the superficial phenomena of our country, still less should we be surprised when the sea was appealed to as having been chiefly instrumental in moulding the land into hill and dale.

There were probably few who began this study, that were not at first more deeply impressed with the energetic action of the waves along a sea-coast, than with the less obtrusive work carried on by the subaërial forces. Gaunt cliffs and long-retiring caves and inlets seemed to assure them, that rather in the restless activity of the breakers, than in the puny rains and rivers of the land, they had found the power which hollowed out the deep places of the earth. No one could heartily accept the theory which referred to atmospheric erosion the moulding of the land into hill and valley, who had not worked out his belief for himself in the field. This was the only way to learn what denudation, whether submarine or subaërial, really was. When we came impartially to consider the subject, we should find that a vast variety of agents had been at work, from the earliest geological times, in shaping out the contour of our country. Thus, it was not disputed that subterranean movements of elevation and depression, and the waves and currents of the sea, had, in many cases, determined the direction in which streams and rivers should flow; but the cutting out of the valleys and the fashioning of the hills must be attributed principally to the action of the atmospheric forces.

No one-sided theory, therefore, that should seek to explain all the phenomena by reference to one set of influences alone could be accepted.

On the present occasion, Mr. J. Geikie could not pursue this subject further. The origin of our mountain and valley systems dated back to much more remote periods than the advent of the Glacial epoch; and there was nothing more certain than this—that the direction followed by the Glacier ice of that age was influenced to a great degree by the pre-existing configuration of the country. In selecting matter for illustration, he thought it better to confine himself to one small corner in this great field of inquiry, in the belief that by thus restricting the sphere of their investigations, they should be enabled to attain a better idea of the scope and bearing of the general question. The subject proposed to be considered was denudation in Scotland since Glacial times. Now it was very evident that before we could have any proper notion of the denudation of a country, we should first ascertain, as well as we could, the nature and geological origin of the rocks which appeared to have been denuded. For it was plain that until we knew how these rocks came to be amassed, we could never hope to gain any proper estimate of the degree of erosion to which they might have been subjected since the time of their formation. How could we expect to appreciate the amount of waste which strata had experienced, until we had first carefully examined these, and considered their geological relations, and gathered together all the evidence we could with regard to their former extension? Denudation was thus a much more complicated study than it might at first appear to be; and he would repeat that it could only be thoroughly grasped by those who were content to work the matter out for themselves in the field. No doubt we might make up our minds on book evidence as to the probability of this or that theory of denudation; but it was one thing to believe—it was a very different thing to feel that we believe.

Before we could arrive at any conclusions regarding denudation in Scotland since the Glacial period, the deposits of that age must be critically examined. We must inquire into the mode of their accumulation so as to ascertain what degree of waste they had sustained since deposition, and how much of that erosion might be due to the action of the sea during the marine stage of the Glacial epoch—how much to that of the atmospheric forces in subsequent times. In short, our investigation should involve a study of the whole history of the Drift formation. In the remarks that were to follow, however, he did not pretend to offer anything like a digest of that history. On the contrary, he would limit attention to those portions of the evidence that seemed best fitted to recall the general aspect which appeared to have been presented by the drift accumulations during the various stages of the Glacial period.

The lecturer then described some of the more characteristic features of these deposits of clay and sand and gravel which are so abundantly scattered athwart the face of the country, and to which geologists had given the general title of the "Glacial or Drift Formation." These accumulations were found capable of being divided into more or less well-defined groups, relatively of different ages, but all belonging to one great geological period. At the base we had the stony "Till," or Boulder-clay, and above that, in certain cases, came vast heaps of sand and gravel; while in other districts the Till was overlain by finely stratified fossiliferous clays, or sometimes by a very coarse Upper Boulder-clay. Much still remained to be done in the working out of the history of these deposits in detail, but the general succession of geological changes which they indicated were nevertheless sufficiently ascertained.

Geologists were agreed that the observed phenomena could only be explained by reference to what is now taking place in arctic and alpine regions. The rounded contour of our hills, the flutings and sculpturings of our valleys, the scratched and polished rock-surfaces that everywhere abounded, bore emphatic testimony to the former passage of a great sheet of ice, under which, at some distant period, these islands of ours, in common with the high latitudes of Europe, Asia, and America, lay buried—only the loftier mountain tops peering above the desolate waste. And in like manner did the accumulations of sand and gravel and clay, and the pell-mell heaps of the Upper Boulder earth, testify to the subsequent presence of the sea over certain areas of the same regions.

Mr. Geikie stated that during the early stages of the Glacial epoch the surface of our country, by the constant grinding action of the great ice-sheet, came to assume certain characters which are still very legible. He showed that the general trend of the ruts and scratches impressed upon the rocks by the passage of the glaciers was, in the northern hemisphere, from north to south, but that the form of the ground often had considerable influence in turning them from that general direction. Thus in our own country they were found to radiate downwards from the high grounds, following the lines of the principal valleys.

During the continuance of this Arctic condition of our country, the waste of the underlying rocks must have been considerable. Mountains of schist had been in some measure deprived of the outlines which, under usual atmospheric action, they must have assumed. Hills of shattered and much jointed greywacké, which ought to rise up in broken, serrated, and peaky tors, showed instead a rounded and hummocky contour. Valleys which, from the nature of their strata, we should have expected to present steep or vertical walls, have been moulded into smooth and undulating hollows. Glens, at one time roughened with countless crags, and bristling with jagged points of rock, have had their sharp angles and rude corners cut away—the present ruinous and tumbled aspect of many of our Highland glens being due to subsequent atmospheric waste, which was gradually effacing the traces of Glacial action. The waste material that resulted from all this scooping and grooving and planing went to form the Boulder-clay. Some of it gathered underneath the great glacier as a *moraine profonde*—some of it was carried out to sea by icebergs.

The character and mode of accumulation of the true Lower Boulder-clay were next described. As the "ground moraine" of the old ice-sheet, it gathered most abundantly over the surface of the lowlands, its occurrence at considerable elevations being the exception to the rule. It was remarked that in districts where the marine drift occurred, the Boulder-clay had usually suffered much erosion, while in regions where the sand and gravel did not appear, it had commonly a much less denuded aspect, often forming well-marked terraces in upland valleys, and in straths frequently showing parallel mounds or broad ridges, which were probably, in the main, original inequalities acquired while the till was in course of formation as a *moraine profonde*.

The character and mode of accumulation of the upper or marine drifts were next considered. It was shown that these deposits consisted chiefly of sand and gravel, at other times of a coarse Boulder earth, and in some places fossiliferous clay also occurred. These beds had no doubt been derived chiefly from the waste of the Lower Boulder-clay, and also in some measure from the droppings of icebergs. In a district were the sands and gravels were typically developed it was often found that, as we left the central parts of the broad valleys and straths and approached the contiguous higher grounds, these drifts appeared to thin away from heaps of well-stratified materials to meagre, irregular sprinklings of earth and stony rubbish. The fine sands and gravels with diagonal bedding occupied chiefly the bottoms of the valleys, the kaims and mounds of coarse and angular *débris* lay for the most part along the hill-sides. These facts appeared to point to a passage from a deeper to a shallower sea-bed. The capricious distribution of the sand and gravel was then touched upon, and it was shown how this might give us an index to the probable maximum of depression attained during the marine period. The evidence furnished by the angular gravels, which seemed to mark out the upper limits reached by the Glacial sea, agreed with the independent testimony derived from the occurrence of the kaims in certain valleys and their absence from others. If we supposed the land to be submerged to the highest levels reached by the coarse angular gravels it would be observed that kaims only occurred in such valleys, as on a depression to this extent would form straits, channels, or comparatively open seas—that it was precisely in the same localities where the lower till was excessively eroded—while in those valleys which, under like conditions, must become long narrow fiords, marine drift did not appear, and the Boulder-clay had not been subjected to the same degree of denudation. In the straits marine currents would have free scope to plough up the deposits of the earlier period, while in the narrow firths no such action could be carried on, as we learned should be the case from a study of our own Highland sea lochs or the fiords of Norway. The later drifts, consisting of terminal moraines and that surface-wash which seems to have gathered under the snow or *névé*, showed us that, after the re-elevation of the land, glaciers continued to reach the sea for a time, and in their downward progress from the snowfields, scooped out the accumulations which had formed during the previous ages.

Having thus given a *resumé* of facts connected with the mode of occurrence of the drift deposits, and the kind of erosion to which they were subjected during the Glacier period itself, the lecturer then proceeded to examine the nature and degree of subaërial waste experienced since the close of the great age of ice. Every geologist was familiar with the glaciated outline of the elevated regions of our country. The rounded crags, the smoothed and fluted hill sides, and the finely striated rock-surfaces were characters so well-known that he had only to mention them. When he said that these were to be met with everywhere, of course he did not mean that every declivity would show its ice-mouldings, every crag exhibit *roches moutonnées*, or every exposed surface of rock exhibit a series of striations. Such must, no doubt, have been the case when the great ice-sheet first disappeared, but during the long ages that had since elapsed chemical decomposition, frost, and rain had succeeded in obliterating many traces of the ancient glaciers. Notwithstanding all this, however, the memorials of the former presence of a vast body of ice were so abundant that we could not but conclude that the solid rocks of our mountains had suffered comparatively little waste since that covering of ice had vanished. A visitor from Alpine countries, where perennial snows and glaciers abounded, would see little in the outline of our Scottish mountains with which he was not familiar. The finer touches of the great ice chisel would oftentimes indeed be wanting, but its broad effects would all be there, reminding one who wished to be fanciful, of those ancient sculptures from which the hand of time had effaced the delicate finish of the artist but had been powerless to destroy his design.

Mr. Geikie next considered the present aspect of the Boulder-clay. He said that in our valleys and straths we could read the history of a Glacial period with as little difficulty as we deciphered its records at higher levels. It was admitted that the subaërial waste experienced by the Boulder-clay had been great, but when we came to estimate what effect this erosion had had in modifying the general aspect of that deposit it appeared to be scarcely appreciable. The greatest waste experienced by the Till took place during the growth of the marine drifts. Waves and currents in narrow straits and open seas had often made havoc of the Boulder-clay, while in the fiords and other sheltered regions the some degree of waste could not be effected. And the configuration thus given to the lower Till had not been obliterated by the atmospheric forces, although these had been so long employed in its reduction. If frosts and rains and rivers had been unable to deprive the lower Till of the general aspect it assumed on the re-elevation of the land, they had been just as powerless to efface the external character of the upper or marine drifts. So perfect were the forms of mounds and kaims of sand and gravel that these were capable of being classified and described by reference to the various kinds of bars and banks of analogous materials which were gathering on the bed of our own seas at the present day. But just as it was seen that the Boulder-clay had been extensively denuded by atmospheric agents, so we learned that the marine drifts had undergone no inconsiderable degree of erosion. From some valleys they had well nigh vanished; in others the kaims had been obliterated and their materials re-assorted by the streams and rivers.

After referring to the proofs of this waste, Mr. Geikie went on to remark that a study of the valleys in which the kaims had been thus denuded would convince the geologists that in former ages our rivers must have greatly exceeded in size their present representatives. The position of some of the older alluvia, and the evidence of river action in places to which streams of the same size as now flowed in the valleys never could have attained, all led to this inference. He thought it extremely probable that it was during the age of forests, when Britain formed a part of the continent, that our rivers reached their greatest development. There were good grounds for believing that at this period glaciers filled some of our higher valleys. In some of the high level river gravels, also, we often met with large boulders, which appeared to have been ice-borne to their present position. And the testimony derived from the nature of the timber dug out of the peat-mosses was quite in harmony with such a supposition. For the climate that nourished the large pine-trees of the English mosses must have covered our rivers with ice in winter. While this excessive climate prevailed, atmospheric waste, no doubt, went bravely on; and even down to much later days, when the peat-mosses were increasing and the ancient forests decaying, the work of denudation must have proceeded more rapidly than now.

Some examples of post-Glacial waste were then cited. He mentioned the case of the gorge through which the River Doon makes its way after escaping from its parent lake. In cutting out this ravine, a mass of rock, equal to at least 70,000,000 of cubic feet had been removed bodily by the stream; and many similar cases might be adduced. But although, locally considered, the denudation thus experienced by drift deposits and subjacent rocks might be often great, it would require a far longer lease of time than had elapsed since the close of the Glacial epoch ere the characteristic features impressed upon our hills and valleys during that period could be effaced. In conclusion, he said they could not fail to be impressed with one consideration, which, above all others, seemed to stand out prominently after a review of such matters as they had been that evening considering—and that was the enormous time required to produce the broader effects of denudation. How many long ages had rolled away since these islands rose above the level of the Arctic Sea in which our marine drifts were amassed, and yet, during all that time, how little change had come upon them at the instance of the atmospheric forces. And if the records of the old Arctic condition—the delicate ice-markings on the rocks, the loose incoherent deposits on the hill-slopes and plains—still remained so perfect, notwithstanding the ceaseless activity of the denuding agents—if the mere skin as it were, and surface-markings of the land were still so largely retained, what should we say to the time required for the growth of that covering itself, and for the production of these strange ice-mouldings and flutings,—and how, above all, could we apprehend (for comprehend we could not) the truly tremendous lapse of time, during which the solid land was gradually sculptured into hills and valleys by the rains and frosts and rivers of the past.—*The Glasgow Herald, November* 30, 1867.

II.—ON THE INTERNAL HEAT OF THE EARTH. By DR. JULIUS SCHVARCZ, F.G.S.[1]

THE author reviewed the evidence upon which is founded the doctrine of central heat as applied to the earth. It is based on three arguments. *First*, gathered from volcanic phenomena,—phenomena which may be explained by the chemical and electro-chemical schools of geologists, at least as satisfactorily as by the supporters of central fire; the *second* argument is adduced from the nebular hypothesis, an hypothesis having now-a-days no other foundation than what is involved in it from the central fire hypothesis; and the *third* is adduced from the supposed uniform increase of temperature down to the centre of our planet, in every part of the earth,—an argument which is again a mere hypothesis.

Having carefully studied the literature of the subject, Dr. Schvarcz criticised the observations upon which the hypothesis of central fire is supported, and showed how imperfect and conflicting is the evidence to prove that the increase of underground temperature is really general and uniform.

Before generalising, we must accumulate a greater number of facts, precisely recorded, than are at present at command, and he therefore urged geologists to combine all their efforts in order to multiply geothermometrical observations, especially in countries now unexplored.

He was of opinion that solar impressions of all the climates on our earth's surface, taken collectively, and local reservoirs of lava, not exceeding considerably the depth of thirty-five geographical miles, and manifesting themselves through volcanic cones from local processes of oxydation, must be taken for those secondary causes which remain indispensable elements of any ætiology of underground temperatures, even for theories to come. Electricity, as connected with cosmical magnetism and planetary rotation, may have been an important agent, besides the secondary causes just alluded to.

III.—ON A NEW PHOSPHATIC DEPOSIT, NEAR UPWARE, CAMBRIDGESHIRE. By J. F. WALKER, B.A., F.G.S., &c.

IT is unnecessary here to give a lengthened account of Mr. Walker's paper (read before the British Association, Dundee) as most of the facts have appeared in two previous numbers of the GEOLOGICAL MAGAZINE.[2]

The author repeats his opinion that this Phosphatic deposit is of the age of the Lower Greensand—it contains fossils of that age as well as extraneous specimens. The bed contains sponges resembling those of Faringdon; and during a recent visit to that locality he obtained several shells which he has also found at Upware.

The phosphatised casts of shells found at Upware, and also at

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[1] Being an abstract of his paper read before Section C. of the British Association, Dundee, September, 1867.

[2] GEOLOGICAL MAGAZINE, July, 1867, p. 309. *Ibid.*, October, 1867, p. 454.

Sandy, he regards as derived from the denudation of older deposits; because they are much water-worn, and often bored by Mollusca.

Bryozoa and *Serpulæ* occur attached to the surface of several of the phosphatic nodules at Upware.

REVIEWS.

I.—MORTILLET'S "MATERIALS FOR THE HISTORY OF MAN." 3rd Vol. Nos. 1-8 (in Five Nos.) [MATÉRIAUX POUR L'HISTOIRE POSITIVE ET PHILOSOPHIQUE DE L'HOMME: BULLETIN MENSUEL, etc., par GABRIEL DE MORTILLET. Troisième Année, 1867. 8vo. Paris.]

THIS useful monthly compendium of facts and notions, either published day by day, or communicated to the Editor, about Anthropology, Prehistoric Times, the Quaternary Epoch, the Origin of Species, and Spontaneous Generation, has now reached its third year, and steadily fulfils its mission in aiding the advance of a scientific knowledge of the history of early Man, and of collateral natural-history subjects bearing on the character of races and states of culture. The last two parts of this useful work M. Mortillet has judiciously devoted to a succinct account of everything contributed to the Universal Exhibition at Paris that at all bears on primæval Man and his habits and character. Every quarter of the globe contributed something, though not always arranged in the special galleries illustrative of the History of Labour and Art. Every noticeable object, however, is classified by the Editor in these his "Promenades Préhistoriques à l'Exposition Universelle;" and, as far as possible, they are grouped under such subdivisions as "Caverns," "Quaternary Deposits," "Stone Epoch," "Ground and Polished Stone Implements," "Bronze Age," "Iron Age," etc. After viewing all these very interesting objects, never to be again assembled under one roof, M. Mortillet draws the following conclusions (pages 366, etc.).

It is impossible, he says, after having visited the Galleries of the History of Labour, supplied by Wurtemberg, Hungary, Switzerland, Spain, Denmark, Sweden, Norway, Russia, Italy, England, and especially France, to have any doubt of the existence of a great Law of Progress in Human Nature. We see Industry begin with instruments of Stone, mere flakes, so primitive and rudimentary that they are inferior even to such as are used by the least advanced of existing savages. Little by little the stone is better worked, and its use becomes more varied; and there are numerous implements of bone and deer's horn. Then comes the art of grinding stone; marking an era of progress, and characterizing one of the great divisions of Pre-historic Time,—namely, the Era of Polished Stone. Still later it was that Metal appeared; at first Bronze alone and afterwards Iron. Stone chipped and flaked, Polished Stone, Bronze, and Iron, are so many successive characteristics of Human Progress before reaching our present civilization. Not only was it possible in the Exposition to follow step by step this onward march of progress, but even to recognize the chronological blank without which we cannot realize this progress. The chronology taught in all our schools is terribly distanced. Indeed it scarcely covers the historical period. In the Temple of Edfou, erected by the Egyptian Government in the Park of the Exposition, we see the statue of Chephren, a veritable work of art, to which learned Egyptologists assign an age of 6000 years,—a date contemporary with "the first man" of our school-teaching! How long a series of years, or rather of ages, must we not allow for man, once using stone flakes, not only to attain the art of grinding and polishing his implements of stone, but to develop the genius of the Sculptor and give life and sentiment to the hardest rock! There has been an enormous lapse of time! Indeed, Chephren was a cotemporary of a fauna altogether similar to that which exists; whilst, on the other hand, the man who only used chipped stone was surrounded by animals now quite extinct! It is fossil man, then, that lived with fossil animals!

In France, England, and Spain, and at Rome, stone implements of the first period are found associated with bones of the tichorhine Rhinoceros, the great Hippopotamus, various Hyænas, the great Bear of the caves, the Megaceros of Ireland, the fossil Tigers or Lions, and Elephants, among which, especially, the hairy Mammoth is well known. Stone implements made by Man lie in place with these bones, in undisturbed deposits, and nowise rearranged; and hence they are decidedly contemporaneous, one being as much fossil as the other. For these conclusions the glass-cases on the left-hand side of the first saloon of the "History of Labour" could leave no doubt. To this first period in the infancy of Mankind, characterized by a fauna comprising many now extinct species, succeeded a second period, during which there lived in our lowlands, and abundantly too, species that have emigrated, and are now found only in the north or on snowy mountain-heights. Such are the Reindeer, the Glutton, the vulpine Lagopede, the Musk-ox, the Chamois, the Ibex, the Marmot, the Heath-cock, etc. At that time there was progress; for Man began to be an artist. He figured animals; and he has left for us in France representations, not only of the animals that have retreated to cold regions, but also of some of those species which were dying out. The Man of that distant epoch has perfectly represented (together with the Reindeer and the Ibex, which have emigrated) the great Bear, the cave Lion, and the Mammoth, all of which are extinct; and the figures were usually made on the Reindeer's antlers or on the ivory of the Elephant itself. Man was incontestably contemporaneous with these creatures, whose forms he represented so well, and whose bones, teeth, and horns he utilized in various ways. Of this we could not have more convincing evidences.

The age of man goes back, then, to the later geological times, far away beyond the time of Chephren and of classical chronology!

The comparative study of objects of prehistoric antiquity and of objects now used by savages leads to the statement of another law, which completes, as it were, the law of Progress. It is the Law of

Similarity of Development in Man. We find the greatest analogy—the most striking similarity—between the elementary civilization of savages and the primitive civilization of Prehistoric Times. We may say that throughout, in time as in space, Man has followed the same evolution, on the whole, in his industrial as in his moral developement. Thus (1) the Law of Human Progress, (2) the Law of Similarity in Development, and (3) the High Antiquity of Man are three facts, clear, precise, and irrefutable, which come out from this study we have made of the Great Exposition.—T. R. J.

II.—G. LINDSTRÖM'S TRIASSIC AND LIASSIC FOSSILS FROM SPITZBERGEN.

[Om Trias-och Juraförsteningen fran Spetbergen af G. Lindström. 4to. 1866. From the Transactions of the Royal Swedish Academy of Sciences, vol. vi. no. 6.]

IN 1837 Professor S. Lovén collected in Spitzbergen some fossils different from the palæozoic specimens previously obtained there; and he recognised that they were allied to, if not identical with, some Jurassic forms from Petschora Land, described by Keyserling, and even in part occurring in the Jurassic beds of Western Europe. Numbers of these Jurassic fossils of the high North were obtained by Professor A. E. Nordenskiold in Prof. Otto Torrell's first expedition to Spitzbergen in 1858. In the second expedition (1861) Prof. Blomstrand brought home many new Jurassic things, besides other species belonging to a geological period not previously recognized in Spitzbergen, and which, after careful comparison in several German Museums, Dr. Lindström has determined to be Triassic. To these is added the collection made by Prof. Nordenskiold in 1864 on the Isfjord and Storfjord. To describe these fossils is the object of Dr. Lindström's memoir.

I. *The Triassic Fossils.*—These came for the most part from two points, Cape Thorsden and Sauriehuk, situated inside the Isfjord, on the tongue of land jutting out between the Nordfjord and Klaas-Billen Bay, and termed Midterhuk by Prof. Blomstrand in his geological notes on the voyage to Spitzbergen in 1861 (Transact. Roy. Acad. Stockholm, vol. iv. no. 6, p. 44). According to him this consists chiefly of a black and bituminous shale, here and there alternating with layers of harder rock, and overlain by a hard sandstone. Most of the fossils are from strata at Sauriehuk, which, according to Prof. Nordenskiold's communication, rest on somewhat different shales at Cape Thorsden. These latter contain only two or three species, the leading form of which (*Halobia*) is distinct from *H. Lommeli*, characteristic of the upper beds. *Nautilus Nordenskioldii*, sp. nov.; *N. trochleæformis*, sp. nov.; *Ceratites Malmgreni*, sp. nov.; *C.* (?) *Blomstrandi*, sp. nov.; *C. laqueatus*, sp. nov.; *Ammonites Gaytani* (Klipstein), var. (?); *Posidonia; Halobia Lommeli*, Wissmann; *H. Zitteli*, sp. nov.; *Monotis*, sp. indet.; *M. filigera*, n. sp.; *Pecten*, sp. indet.; *Lingula*, sp. indet.; *Encrinus*, sp. indet. (near *E. granulosus*, Münster). Some obscure fragments of other fossils occur, comprising some small black seed-like bodies.

The relationship that some of these fossils have with Triassic species found in the Eastern Alps, in the Himalaya, in New Zealand, New Caledonia, and California, is noticed by the author, also the wide-spread occurrence of this formation of Secondary age.

II. *The Jurassic Fossils.*—Most of these have been found in a usually grey sandstone and limestone, occurring at several points on the coast of the Isfjord. The greatest number were collected in 1861 by Prof. Blomstrand at Advent Bay. The same kind of fossils in a similar sandstone and in shale were found at Green Harbour and Kyss-stugan, also on the east side of Advent Bay, by Lovén, Nordenskiold, and Blomstrand. Also in 1864 Nordenskiold got a harvest from a thin black laminated limestone at Sassen Bay, and in a hard shaly limestone, weathering reddish brown, at Cape Agardh in the Storfjord: *Ichthyodorulites; Serpula; Ammonites triplicatus,*[1] Sow.; *Belemnites; Dentalium; Panopæa; Tellina; Cytherea; Cyprina inconspicua*, sp. nov.; *Cardium concinnum*, Von Buch; *Solenomya Torelli*, sp. nov.; *Nucula; Leda nuda*, Keyserling; *Inoceramus revelatus*, Keyserl.; *Aucella mosquensis*, Von Buch, var.; *Pecten demissus*, Bean; *P. validus*, sp. nov.; *Ophiura Gumaellii*, sp. nov.

The close alliance of the Triassic fossils of Spitzbergen with those of Petschora Land and of Russia, and their correspondence with the Lower (Great) Oolite of Western Europe, is especially noted by the author.

Some obscure plant-remains occur in the above mentioned Jurassic beds; and besides these some Miocene Plants (*Dombeyopsis aceroides* and *Sequoia Langsdorfii*) are found at the same places, apparently mixed with the Jurassic beds, but probably either really overlying the latter, or mingled with them by some disturbance.

This interesting notice of the Secondary Fossils of Spitzbergen adds greatly to our knowledge of that interesting outlier of the European Continent. Carboniferous fossils are known to abound in that Island; and one block, at least, of Permian limestone has been found on the coast, but it was either a drifted fragment, or was derived from the ballast of some wrecked whaler.

The Carboniferous rocks lie on unfossiliferous schists and conglomerates; these on unfossiliferous slates, quartzites, and marble; these on a lower series of slates, etc., and these on gneiss and granite. Thus, as Murchison has suggested, all the Palæozoic formations, from the Laurentian upwards, may be present there. The coal of Spitzbergen is of Tertiary age.

See also Mr. Lamont's paper on Spitzbergen in the Journ. Geol. Soc. vol. xvi; Nordenskiold's memoir in the Trans. Roy. Swedish Acad. 1866; Siluria, 4th. ed. p. 543.—T. R. J.

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[1] A fragment of *Ammonite* was collected by Mr. Lamont at Bell Sound, see Journ. Geol. Soc. vol. xvi. p. xii. and 436.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON. — November 20th, 1867. Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair. The following communications were read:—1. "On the Glacial and Post-Glacial Structure of Lincolnshire and South-east Yorkshire." By S. V. Wood, Jun., Esq., F.G.S., and the Rev. J. L. Rome, F.G.S. The features of Yorkshire and North-east Lincolnshire, having distinctive characters from those of Central and South Lincolnshire, the authors described the two areas separately. In the former, their coast sections exhibited the Glacial clay separated into two portions; of these the lower, which they identified with the ordinary (or upper) Glacial clay of the south, contains abundant chalk débris; but the upper or purple portion (which was in places divided from the lower by sand or gravel beds) contains no Chalk in the upper, and but little in the lower part of it, the place of the Chalk being taken by swarms of Palæozoic fragments. The latter of these clays alone extends over the Wold-top at Speeton, and alone occupies the valley along the northern Wold-foot, and so away northwards to Scarborough, and the Tees' mouth, from which the authors inferred that the north of England did not subside beneath the Glacial sea until after the south had been submerged. The so-called Bridlington "Crag" was shown to be an intercalated bed in this purple clay. Both these clays were shown to be denuded, and their denuded edges to be everywhere covered by a much thinner Boulder-clay, that of Hessle, which wraps Holderness like a cloth, extending to altitudes of 150 feet, and running down the east of Lincolnshire to the Fen-border. This Post-glacial Boulder-clay of Hessle is again cut through, and in those places covered by posterior beds of gravel, one of which (at Hornsea) contained fluviatile shells. At Hull this clay supports a forest, which is now submerged 33 feet below the Humber; the same submerged forest also occurring at Grimsby. The authors regarded the position of the sea during the Post-glacial period as having been principally on the west of the Yorkshire and North Lincolnshire Wold until the formation of the gravel-troughs, cutting through the Hessle clay, and that its present position was connected with a recent westerly elevation and easterly depression.

The Glacial clay of central and South Lincolnshire belongs to the chalky portion, from which all the superior or purple part of the formation has been denuded; and the valleys of Central Lincolnshire were shown to be cut out of the Cretaceous series and Glacial clay as a common bed, the hills formed of the clay rising to elevations equal to the Wold in that part.

The Glacial clay of both areas was shown to be denuded westwards; and the denuded edges occupied with sands and gravels, termed by the authors denudation-beds.

2. "On supposed Glacial markings in the Valley of the Exe, North Devon." By N. Whitley, Esq.

Mr. Jukes having, in a late paper, mentioned some glacial grooves observed by him in the valley of the Exe, the author stated his opinion that the "Grooves" have been formed by the minor contortions of the strata, and not by glacial action.

3. "On Disturbance of the Level of the Land near Youghal, in the South of Ireland." By A. B. Wynne, Esq., F.G.S.

The object of this communication was to place upon record certain facts connected with alterations of level in the shore of the South of Ireland, near the town of Youghal. The occurrence of submerged peat beneath the Youghal strand shows that considerable alterations of level have taken place along the coast of Youghal Bay subsequently to the formation of the peat which so commonly covers the Glacial Drift of Ireland. The author also inferred that toward the close of the Glacial period the sea was further from the present land than it is now; that the land then sank to the depth of about 90 or 100 feet, and subsequently rose again, but not to its former level: and, in conclusion, he pointed out the probability of its undergoing depression at the present time.

II. December 4th, 1867.—Robert Etheridge, Esq., F.G.S., in the Chair. The following communications were read:—I. "On the Graptolites of the Skiddaw Series." By Henry Alleyne Nicholson, D.Sc., M.B., F.G.S., etc.

The author first described the geological relations and distribution of the Skiddaw Slates, and noticed their correspondence with the Quebec Group of Canada, and then gave a description of the Graptolites found in these rocks. The genera and their distinguishing characters are as follows:—

1. *Dichograpsus*, Salter (3 species): possesses a frond, repeatedly dichotomous from a basal stipe into 8, 16, or more branches, each with a single row of cells, the lower part of the stipe being enveloped in a corneous cup.
2. *Tetragrapsus*, Salter (3 species): possesses a frond composed of four simple stipes, arising from a non-celluliferous funicle, which bifurcates at both ends.
3. *Phyllograpsus*, Hall (2 species): differs from the last in possessing a frond composed of four simple stipes united back to back by their solid axes.
4. *Didymograpsus*, M'Coy (7 species): the frond consists of two simple stipes, springing from a mucronate radicle, which may be rudimentary or apparently absent.
5. *Diplograpsus*, M'Coy (4 species): two simple stipes, united by their solid axes into a celluliferous frond furnished with a radicle at the base.
6. *Graptolites* vel *Graptolithus*, Linn. (4 species): simple stipe, with a single row of cells on one side, and a small, generally curved, radicle at the base.
7. *Pleurograpsus*, Nicholson (1 species): celluliferous branches derived from a main celluliferous rhachis.

II. "On the Fossil Corals (*Madreporaria*) of the West Indian

Islands.—Part IV. Conclusion." By P. Martin Duncan, M.B., Sec. G.S.

In this communication the author concluded his series of memoirs on the Fossil Corals of the West Indies with a description of the Miocene corals from St. Croix, Trinidad, and with some supplementary remarks on the species described in his former papers from St. Domingo, Jamaica, and Antigua, including notices of new species from those islands. He also gave a complete and revised list of all the fossil corals he had described from the West Indies, including five species from the Cretaceous strata; four species and one variety from Eocene deposits; and one hundred and two species and twenty-six varieties from the Miocene formation, making a total of one hundred and eleven species and twenty-seven varieties. Of the Miocene species eleven still exist, namely, six in the Caribbean sea only, three common to that sea and the Pacific Ocean, and two in the Pacific Ocean and Red Sea, but not in the Caribbean. Twelve other species are common to European deposits and the West Indian Miocene, ten being of the same age in both hemispheres, while two occur in the Lower Chalk in Europe. These twenty-three species being deducted from those of the West Indian Miocene, a large characteristic fauna still remains; and Dr. Duncan showed that the recent representatives of the characteristic genera composing it are for the most part inhabitants of the Pacific and Indian Ocean, the Red Sea, and the Australian waters, and that their Tertiary congeners are found in Europe, Australia, Java, and Sinde. Of the fourteen genera thus enumerated, eight are not represented in the recent coral-fauna of the Caribbean sea.

Jamaica has yielded the only known Cretaceous and Eocene corals; and Dr. Duncan stated that the former are identical with European Lower Chalk species; and that the latter are similar to species from the London Clay, the Bracklesham Beds, and the Paris Basin.

Dr. Duncan then mentioned several curious facts in the distribution of the West Indian corals, both fossil and recent, and especially the circumstance that whilst Jamaica, San Domingo, and Guadaloupe present solitary species, mixed with those indicating shallow water and a reef, Antigua and Trinidad offer for consideration only reef-species. In conclusion, the author drew attention to the confirmation by subsequent discoveries of his theory of an Atlantic archipelago, which he had put forward in his earlier papers.

GEOLOGISTS' ASSOCIATION, UNIVERSITY COLLEGE, LONDON.—On December 12th, 1867, MR. HENRY WOODWARD delivered a lecture to this association, "On Recent and Fossil Crustacea," in which he pointed out the great interest attaching to this group, not only on account of its wide geographical distribution, but also its early appearance in geological time. He considered that the division *Articulata* was, probably, almost of as great zoological value as the sub-kingdom *Vertebrata*: that, in fact, in palæozoic times, the representatives of the *Articulata* fulfilled the functions afterwards performed by fishes and reptiles—that the *Articulata* alone, of all the *Invertebrata*, possessed the powers of aërial, terrestrial, and aquatic progression, and in as great perfection as the *Vertebrata*.

Mr. Woodward called especial attention to those orders and families of crustacea which are of greatest interest to the palaeontologists, because they are represented, in some instances, far back in time, their remains being found in oldest Palæozoic strata.

He spoke of those world-wide forms—the bivalve *Entomostraca*, to which Messrs. Parker, Jones, and Brady, have devoted so much attention, which have lived on from Silurian times to our own:—of the *Apus*-like Crustacea, *Ceratiocaris*, *Peltocaris*, *Dithyrocaris*, &c., equally persistent: of the gigantic *Eurypterida*, and their modern relatives, the *Limulidæ*, (these latter appearing, by recent discoveries, to go back in time to the Upper Silurian)[1]:—of the extinct Trilobites and their relationship to *Apus* and *Branchipus*. Mr. Woodward noticed that aberrant group the *Cirripedia*, represented by the "Barnacle" and "Acorn-shell," and their relatives, who prefer whales and turtles backs to live on, rather than the sides of ships. He mentioned that one fossil Cirripede had been discovered as low down as the Wenlock limestone, and that the fossil shell, of a species parasitic on the whale, had been found in the Crag of Suffolk, where such vast quantities of the bones of fossil *Cetacea* are also met with in the Coprolite-diggings in the Crag. He then spoke of the higher forms, the Decapod Crustacea, represented by the Crab, Lobster, and Prawn, and showed that the short-tailed Crabs have, at present, only been found as far back in time as the great Oolite, but that the long-tailed type go back to the Coal-measures.

In conclusion he strongly recommended this group to the attention of Town-members, as, from the London Clay, some of our finest Tertiary fossil Crustacea had been obtained; whilst from the Chalk of Kent and Sussex and the Gault of Folkestone, an equally abundant harvest might be procured.

Mr. Woodward's lecture was illustrated with a large series of Diagrams and Specimens of recent Crustacea, serving to show the wonderful diversity of form and modification of the appendages which are displayed in so remarkable degree by this interesting class.

CORRESPONDENCE.

DENUDATION, AND ITS AGENTS.

SIR,—I am pleased to find that your contributors have of late returned to the attack upon the difficult subject of denudation. There is plenty of room for other workers to labour in other departments of our illimitable science, without this subject being lost sight of. We must be content to undergo a good deal more hard thinking and close reasoning upon it. Fine writing will not solve our difficulties. Even alliteration may fail to help us.

Denudation has been going on for extended ages, and this peculiarity attaches to it, that the last agency at work necessarily obliterates the marks of others which may have preceded it. When, therefore, we are discussing this subject, it is important to avoid misconception by stating clearly what stage of the whole process we are upon. One may say, we have marine action here; another, we have glacial; another. pluvial. Each may be right if he limits his assertion to the proper stage; each will be in error if he carries it beyond. It is as, in describing the fashioning of a board, we might truly assert it to have been cut either by the axe, or by the saw, or by the plane. But if we were to attribute the formation of the smooth surface to one of the two former instruments, the assertion would be incorrect.

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[1] See the first article in the present number of the GEOLOGICAL MAGAZINE, p. 1.

The present phase of the discussion refers, I apprehend, to the final stage of denudation. To use the above illustration again, were I shown a board, and asked by what tool the surface had been brought to its present condition, I should look at two things—first at the *form* of the surface, and, secondly, at the *condition* of it. From the two together, I should be able to arrive at a sure judgment of the mode by which the surface had been produced. Now, I think that these tests have not been carefully enough applied to discover the true cause of the form of the ground. The acknowledged power of rain to carry some portions of the soil into the rivers. and the power of rivers to convey what the rain gives them into the sea, does not prove that the contour of our landscape was produced by these agents. The question to be decided is, whether rains can mould the surface to the particular *form* which it presents, and whether it can remove. not some material, but the particular material of which each locality has been denuded. This is a question concerning the mechanical power of water, in the quantities which rain yields. moving over surfaces having the *minimum* inclination of the denuded country. And when we call in the assistance of the weather to disintegrate the harder rocks so as to fit them for removal by rain, we must recollect that, in cases of unequal solubility. the harder portions would be left. if only temporarily. to accumulate behind, and thus to point out the manner in which the waste of the surface was being effected. Neither must it be forgotten that such pluvial action must have been carried on when all the less elevated parts of the surface were covered with herbage, as they would have been if the climate was not glacial. If it was glacial to the extent of preventing the growth of herbage, then ice action would have taken place.

The second index to the agency which has been in operation is to be found in the *condition* of the surface. It is inexcusable to neglect the study of this, which is to be seen in every shallow pit or ditch that is opened. Such sections always afford an interesting study. We must no longer be content to disguise our slothful ignorance of the true nature of the first few feet of every section under such terms as "heading," "vegetable soil," "rain wash" (unless we can *prove* it such), "rubbish," or what not. There you have a veritable record of the last touch of Nature's hand in fashioning the landscape. Say, what tool did She use? Those contorted layers of gravel, those pebbles set on end, those larger stones suspended in what was once a plastic mud, that distinct line of demarcation between the moved and unmoved ground usually marked with slikenside if you look for it, those beds bent back and dragged down hill—nay, sometimes bent over on level ground: all these are indications of some universal agency, bringing the surface into the state in which we see it. What power was competent to produce, not one of, but all these effects?

The modern changes in the form of the ground, by the growth of peat, the silting up of valleys, the erosion of the banks of streams, the slipping of hill-sides under the action of springs, will help the close student of the subject to arrive at a satisfactory conclusion upon the older mode of denudation; for they will show him that the present agency of rain, and rivers, and springs, is modifying, not continuing to produce, the original contour of the ground. Until all these indications of form and condition of the surface are patiently and honestly studied, this question will continue to vex the geological mind, and to occupy the valuable pages of your Magazine.

O. Fisher.

Harlton, Cambridge.

P.S.—The above was written before the appearance of the December number of the Magazine, and has no reference to the papers therein contained.

THE EARTH'S FEATURES.

Sir,—"*The true views of the operations of nature in sculpturing the surface of the earth can never be arrived at unless we take into consideration the effects of all possible agencies, and give them their due place in the great work.*"[1]

Never were truer words spoken than the above,—*Marinists* may rave about what their special agent can do; so may *Subaërialists* proper, *Glacialists*, and every other *ists*, but unprejudiced observers will find that all the different agencies work hand in hand, and that if any of them had been absent, the present features of the earth could not have been formed as we now find them.

Why is it necessary that any new theory should be invented or any *special* theory adopted to account for the present features of the Earth? Why not rather allow the existing forces to do the work nature has assigned each? Let the changes in the earth be considered from "the beginning," and may not a solution for most, if not for all, the apparent difficulties be found? To suit the *special* theories, various forms have been suggested as the first; but is there one of them so simple or better than that given in The Book—"The earth was without form and void, and the spirit of God moved on the face of the water." From this, the oldest record, it would appear that at "the beginning," the earth was surrounded by an envelope of water. Moreover, this statement agrees with present conditions; for a similar phenomenon might again occur if all the land was sunk in the depths of the ocean. This sea, as proved by Mr. Campbell in "Frost and Fire," must have been motionless, there being no light

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[1] Hull, "Geol. Mag." Vol. IV. p. 569.

—when light was created, motion began, and after that, "the dry land appeared,"—since then there has been perpetual motion, during which, parts of the land have been submerged, while other parts have been elevated; and this process has been enacted over and over again. While the land was above the sea, "Frost and Fire," with "Rain and Rivers," have each in their appointed place done their work; neither was the sea idle, as it must have acted on the land as it was appearing above, or disappearing under the waters, carving out the main features afterwards to be remodelled by the other existing forces.

An observer who has seen the sea yearly carrying away a coast may be inclined to believe that it is the great destroyer; while those who live among soft strata that are easily denuded, may pin their faith to "Rain and Rivers," and those accustomed to Alpine or Arctic regions to ice; but an unprejudiced observer will find that "all are right and all are wrong." Moreover, if the advice of the Chameleon—

> "When next you talk of what you view,
> Think others see as well as you,"

was generally adopted among geologists, it would not be so difficult a task as at present to find "keys to fit all the locks."

The Biblical record may be sneered at because human remains have not been found except among the most recent of the Tertiary deposits. However, in answer to this I may be allowed to put forward Col. Greenwood's suggestion; that *there is only negative evidence against the existence of Man and the other land animals from the earliest periods of the earth;* for to quote that author's words:[1]—"Where are the fossil remains of *land quadrupeds* found? In cavern deposits, in drift and alluvium 'deposited on dry land,' in filled up lakes, in bogs, or frozen up in polar regions. Now all these land museums are not only modern, but they are superficial and temporary. They are liable to be washed into the sea; and their fossil contents *must be* destroyed before they can be re-deposited in marine strata."

G. Henry Kinahan.

Connemara, *Dec. 1st,* 1867.

DENUDATION OF THE WEALD.

Sir,—In your December number, page 572, Mr. Mackintosh names me as "Colonel Greenwood, the father of modern subaërialism." And thereupon he puts this question to me, "If rain has washed away the soluble chalk, what has become of the insoluble flints?" In reply I would ask Mr. Mackintosh where do "surface flints" come from? I have said "Everything on the surface of the earth which is not living is decaying. On this decay depends soil. On soil, vegetable life. On vegetable life, herbivorous animals. On herbivorous animals, carnivorous animals. So that all life depends on decay." At page 211, of "Rain and Rivers," is this passage,—"In chalk countries denudation leaves a *residuum* of flints on the surface, because though these flints disintegrate and though each is surrounded with a white soft surface of decay, they do not decay so fast as the chalk. Notwithstanding the most sedulous *stone-picking*, these flints still make their appearance. And it is the universal opinion among farmers that they *grow*, not in size but in numbers. But, however we may laugh at the idea of the *growth* of flints on land, for the *fact* that surface flints increase in number it is impossible to suppose more competent witnesses than farmers. And how is the *fact* to be accounted for unless they are the residuum of denudation? When sheep in feeding off turnips have trodden the ground firm and the flints loose, I have seen them raked into rows and shovelled into carts. And were it not that the bulk of the layers of chalk which decay into soil, so infinitely exceeds the bulk of the layers of flint which decay into soil, the accumulation of surface flints would soon stop agriculture in chalk districts. But as rain gradually and annually washes away the soil, the plough brings up fresh flints. And this increase of surface flints in number proves a very universal denudation going on at this moment under our own eyes." With regard to "what has become of the insoluble flints," where large bodies of chalk have been removed, such as the ancient cap of the Weald Hill, have we no flint gravel beds? Have we no beaches of flint? What of the flint-gravel of Kensington and Hyde Park? What of the flints in the enormous beaches (Dungeness for instance) between Dover and the Weald at Hastings on the one hand, and between Beachy Head and Hastings on the other? These witnesses once existed in the chalk which surmounted the Weald Hill above Hastings. Countless myriads of tons of them have travelled to and fro in all directions, and these travellers still exist on our coast at Hurst Castle, at the Portland beach, at Slapton sands, at Hellstone, and round the Lands-end and to the north of it. Countless myriads of tons of them have been ground into sand. And as I have said in the chapter on the travelling of sea beach in "Rain and Rivers," "as the wind blows the wave flows, as the wave flows the beach goes." But the wave flows up the shore obliquely and down the shore straight. The water then would heap to leeward unless there was an under-tow to windward. This under-tow carries sand which is fine enough to be held in suspension, and this is the cause of blown sand at the windward end of large beaches. And from Bridport, which is the windward end of Portland beach, millions of tons of sand are exported to every part of the world to make "Portland Cement." This is "what becomes of the insoluble flints."

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[1] "Rain and Rivers," 2nd Edition. p. 199.

Mr. Mackintosh smashes what he calls "Colonel Greenwood's hard gorge and soft valley theory." I laid down the principle that "as sure as there are alternations of hard and soft strata in the course of a river or valley so sure will there be alternations of gorge and alluvial flat." I first generated this theory in accounting for the valleys along the stretch of the soft Weald clay, behind the gorges across the comparatively hard chalk of the North and South Downs. And I said that, owing to this principle, the original *single* Weald Hill had been cut by rain and rivers into *three* ridges, two outside chalk ridges, and one inside Weald Hill. And that these three ridges of hills were as much *formed* by rain and rivers, as the statue is formed by the sculptor. I thought that this was quite simple. Mr. Mackintosh's receipt is more simple still. He first brings in fire to make "longitudinal cracks during axial elevation," then water in the form of currents "deflected and reflected so as to hollow out the curvilinear 'coves' by which the 'capes' are separated. But suppose it could be shown that powerful currents operating at a considerable, not 'too great' a depth, are incapable of scooping out the depressions bounded by escarpments, it would not be more inconsistent with uniformity to suppose a cyclically-recurring intensification of the action of currents caused by sudden upheavals of strata (here we have fire and water together) than to admit occasional strides constituting breaks in the otherwise continuous series of (organic) changes."

This seems so probable that if I remain of the same opinion still, it can only be from being convinced against my will.

In the same number of your Magazine, page 568, Mr. Hull says, "I adopt, though with some hesitation the views of Professor Ramsay, Dr. Foster, and Mr. Topley, regarding the subaërial denudation of the Weald." If Mr. Hull will do me the *honour* to read the chapter on the Weald in "Rain and Rivers," I think that he will do me the *justice* to say that the above-named gentlemen have "adopted" *my* principles, first published in 1853, and again in 1857.

George Greenwood, Colonel.

Brookwood Park, Alresford,
6 *December*, 1867.

THE VALLEYS OF LANCASHIRE.

Sir.—My friend and colleague Mr. Hull in the last number (page 568) has again brought forward and endorsed his views as to the formation of the valleys of Lancashire. As I have now for some time been at work in North-East Lancashire and the adjoining parts of Yorkshire, my silence would imply that the country on which I am engaged bears evidence in favour of his views, whereas the facts, so far as my experience goes, tend towards an opposite conclusion.

He says "Most of the valleys are really double valleys, the smaller being alone due to river denudation, *and the evidence of this lies in the fact* that, the larger, or primary, valleys are filled with terraces of Marine Boulder-clay, and are really plains of marine denudation in their earlier stages." (The italics are mine.) The fact I can corroborate with pleasure, but I must differ from him in the inference. I find myself obliged to go further than my friend and state, that in the district, with which I am acquainted, the Boulder-clay lies also in the "secondary" valleys, and in water-courses of every size and at different levels (even in some of the narrow cloughs down the hill-sides), in short, in many of those "channels and furrows," which Mr. Hull admits to have been formed "by the action of frost, rains, rivers, and glaciers." In fact many of the brooks of this part of Lancashire are simply re-excavating and enlarging fossil

water-courses, and following in the footsteps of their pre-gl
pioneers.

With these facts before me I see no escape from the infer
that, *in this district at least*, the Glacial Sea, so far from *formin*
"primary" valleys, in which it left the Boulder-clay, had not
the power to *obliterate*, in those valleys, many *minor* features fo
by previous subaërial action. R. H. TIDDEMA

GEOLOGICAL SURVEY OF GREAT BRITAIN,
CLITHEROE, *December* 12*th*, 1867.

SEA-CLIFFS AND ESCARPMENTS.

SIR,—In combating the notion that escarpments have been or
ally sea-cliffs, Mr. Whitaker has stated so fully and forcibly
well-known fact that their bases are rarely or never at the
height above the sea-level for any distance, that there woul
first sight seem to be little room for anything more on the sub
Mr. Whitaker's observations, however, having been confined to
Tertiary and Secondary rocks of the South-East of England, it
perhaps be well to shew that his remarks apply equally to the
carpments of other districts. I also note that one of your co
pondents still holds that depression would convert most of the
cipal escarpments of the Centre and North of England into sea-cl
and another, while he admits that the bases of escarpments ar
strictly horizontal, seems to think that their deviations from a
line are either so small, or so very gradual, that they might be
verted into sea-cliffs by inequalities of depression by no means
yond the limits of probability. Vague statements, like the latter
easily made; but, before they can carry any weight with them,
must undergo the test of facts, and figures; and for this end I
drawn up the following table shewing the details of two cases.

ESCARPMENT SURROUNDING THE RIVELIN VALLEY NEAR SHEFFIELD.

NORTH SIDE OF VALLEY.			SOUTH SIDE OF THE VALLEY.		
Height of base above sea-level in feet.	Distance from starting point in miles and chains.	Difference between height of base at each point and mean height of base.	Height of base above sea-level in feet.	Distance from starting point in miles and chains.	Difference between height of base at each point and mean height of base.
1000		+ 300	1000		+ 300
1075	0·40	+ 375	1075	0·42	+ 375
1000	0·60	+ 300	1000	0·76	+ 300
900	1· 0	+ 200	900	1·35	+ 200
800	1·15	+ 100	800	1·72	+ 100 †
775	2· 0	+ 75 *	800	3·50	+ 100
700	2·45	.	700	3·65	
600	2·48	— 100	600	4· 5	— 100
500	3·40	— 200	500	4·18	— 200
400	3·60	— 300	400	4·25	— 300
325	4· 0	— 375	325	4·35	— 375

Let us now see what will be required to make this line a sea-
or, if it were once a sea-cliff, to convert it into the present escarpm

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* Fault between these points.
† Between these points the base is up and down between 800 and 850.

The mean height of the base is about 700 feet above the sea, and it will give the minimum of oscillation if we suppose the land lowered to this amount. But even on this supposition we shall require the lowest point to be *raised* 375 feet, a point only two chains off 300 feet, a point seven chains further on 200 feet, and so on; while at the other end of the line additional *depression* will be necessary, and the heights of the first three points shew that this depression will not always increase uniformly in the same direction. I may add that I have neglected the gashes cut by small streams in the flank of the slope, and taken only the general line of the cliff: had all the lesser windings been followed the result would have been still more striking. This way of treating the matter is, I think, fairer to my opponents, because, according to their view, these gullies were formed after the termination of the process which gave rise to the escarpment itself.

In order to shew more clearly to the eye the facts I am insisting on I have thrown the details of another case into the form of a diagram given in the woodcut annexed. The dotted horizontal line there represents the average level of the base of the escarpment, and the distance between this dotted line and the hard black line at any point shews the difference in level between the actual base at that point and its mean height, and therefore the amount of additional elevation or depression required to turn the escarpment into a sea-cliff. The horizontal and vertical scales are each two inches to a mile.

The cases just given have been taken at random, and, I believe, represent very fairly the general state of the escarpments of the Carboniferous rocks in Lancashire, Yorkshire, Staffordshire, and Derbyshire; to turn these into sea-cliffs, sea-saw work like that described would be required for every one, alike in character but varying in amount for each; now, independently of the improbability

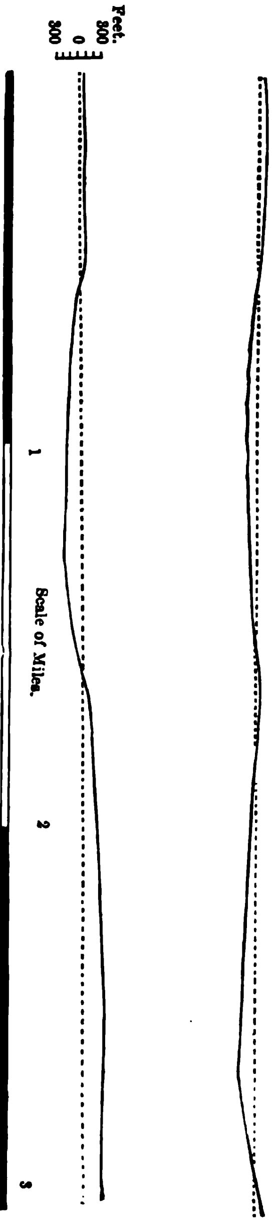

DIAGRAM TO SHOW THE VARIABLE HEIGHT OF THE BASE OF AN ESCARPMENT ABOVE THE SEA-LEVEL.

of Mother Earth ever having been afflicted with St. Vitus' dance to this extent, I do not see how it is possible that such startling inequalities in elevation or depression can have gone on in *solid rocks at the surface* without shattering them to pieces.

Will you also allow me to tell Mr. Mackintosh that I have tried to explain how subaërial agency *may* begin the work of escarpment-making on p. 87, of the Geological Survey Memoir on the country round Stockport, Macclesfield, Congleton, and Leek.—A. H. Green.

Monk Bretton, Barnsley,
December 9th, 1867.

REPLY TO MR. W. BOYD DAWKINS, ON THE THAMES VALLEY DEPOSITS, &c.; AND TO MR. A. H. GREEN, ON THE OUSE VALLEY AT BUCKINGHAM.

Sir,—Before replying to Mr. Dawkins' criticism, I must acquit myself of any undue use of the letter to me to which he refers. I wrote him in reply to it, pointing out privately what I have now done publicly; and asking him, as I valued his palæontogical evidence, to correct what I considered to be a hasty error in his geology. All that I received was a letter, refusing in indignant terms to do this, and challenging me to make out my case. Not the faintest intimation was given me of the mistake in places which Mr. Dawkins now says he made, notwithstanding that I had pointed out to him that Mountnessing and Ingatestone had nothing to do with the valley of the Blackwater, and the position of the Glacial clay near Witham had been shown by me a year previously, in sect. nine of my paper, at page 348 of your third volume.[1] He must have been hurried indeed, if he ran his finger up the Wid to Ingatestone and Mountnessing, instead of up the Blackwater to Witham, when the latter is not only fifteen miles distant from them, but is in another Ordnance Sheet. It was only upon this failure to get corrected, or even qualified, in an unobtrusive way, what I consider to be a fundamental error, that I sent in the note to my paper then awaiting its turn for reading at the Geological Society.

With respect to the brick-earths of Grays and Crayford, I have given so many sections in illustration of their position in the memoir that accompanies my maps in the Geological Society's library, that it would only be unduly occupying your space to endeavour to illustrate the subject here. They must await the investigation of impartial observers, who will study and master, not one, but the whole of the highly complex features of the Eastern Thames valley. All that I would invite Mr. Dawkins, and it seems Professor Morris also, to do, is to show that the gravel of the lower terrace, which, with a thickness of fifteen feet, *passes under the greater part of the Grays brickearth*, be not a part of the same sheet which occupies the valleys of the Darent and Cray, and to which the brickfield at Crayford forms a higher terrace, as shown in my section at page 409 of the twenty-third volume of the Quarterly Journal Geol. Soc.

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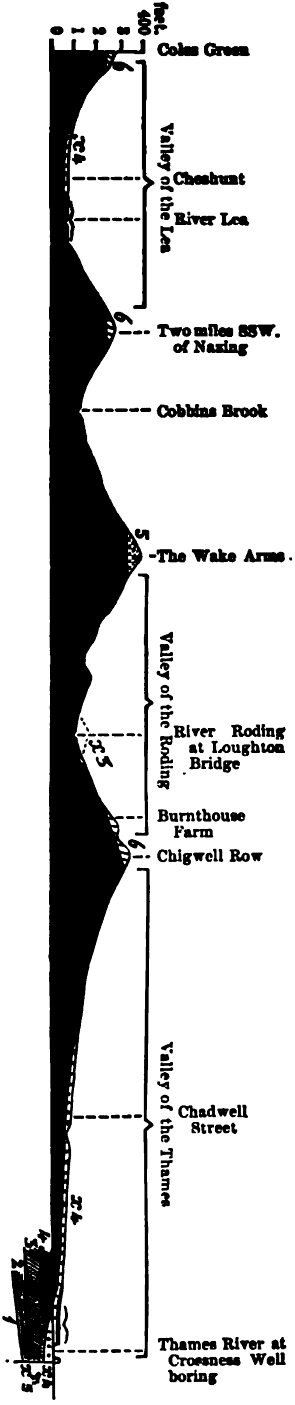
[1] See Little Braxted, which is in the Blackwater valley, and only one mile from Witham Station. As the Glacial clay comes near to Witham, it may very probably be at Witham station, but if so, is not visible, in the Railway section the only bed seen being the gravel.

While Mr. Dawkins reserves a doubt whether the brick-earth of Dartford Heath and Hillhouse be identical with that of Crayford, it is not worth while attempting to show that it is inferior to the Thames gravel; otherwise, I think means could be found to satisfy even himself of that fact.

Mr. Dawkins' position generally is—first, That the chief part of the deposits of the Thames valley are older than the Glacial clay of the northern heights; and the rest, viz., what he and Mr. Fisher term "Trail" (but whose existence as a formation I do not admit), is synchronous with that clay; and—secondly, That the main features of the country around the Thames area were sketched out before the Glacial clay period. With respect to the first of these propositions, I ask Mr. Dawkins either to show that section four at page 398,[1] and section thirteen at page 409, of the twenty-third volume of the Quarterly Journal, and the section I now give are incorrect; or else to explain by what condition of things such a structure as they display could on his hypothesis come to pass. Those who know the Thames valley are aware that a large arm of the chief deposit in it, the gravel, runs up the valley of the Lea. Now the accompanying section shows the relation borne by this gravel to the Glacial clay, both in the Thames and Lea valleys; as well as the struc-



1. Chalk. 2. Thanet sand. 3. Woolwich beds. 4. London clay. 5. Bagshot beds. 6. The upper glacial clay. *x*3. Denudation gravels of the lowest level; these have a considerable development in the Roding Valley. *x*4 and *x*5. Thames gravel. ⁓ Marsh clay, which between Grays and London is underlain by a forest growing on *x*4 and *x*5.—N.B. The mapping shows that the detached tracts of Bagshot beds (of which one is intersected above) were islands in the early part of the upper Glacial sea, and had the Glacial clay deposited around them, becoming, as submergence proceeded, eventually enveloped in it. Length of section 20 miles. The elevations are only approximate.

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[1] By oversight the elevation of Upminster Hall and Cranham Church is made too great in this section, but this has no bearing upon the structure displayed by it.

ture of these valleys, and that of the Roding, where the southernmost outliers of the Glacial clay occur, being those nearest to the common point of inosculation of the three valleys. Unless this section be wrong, I submit that if the posteriority of the Thames gravel (x 4 and x 5) to the Glacial clay be doubtful, then the posteriority of the implement gravel at Bedford to the same clay must be doubtful also; for, so far as this relative position goes, the two gravels are identical—what I contend being, that though both are posterior to the Glacial clay, the Thames gravel is much older than the Bedford, in the latter part only of which contention Mr. Dawkins agrees with me. Palæontological evidence is a valuable auxiliary to Geological position, but cannot override it; and if the two clash, the latter, I submit, should prevail. My own belief, however, is that they never *really* clash, and that the present case, where the Palæontology, as deduced by Mr. Dawkins from the Mammalian remains and the physical Geology, as deduced by myself, so strictly agree is an instance of this. I also ask whether this section can be reconciled with the other of Mr. Dawkins' propositions, viz., that the main features of the country were sketched out before the Glacial period? Is it not evident that the three valleys have been formed by a great denudation posterior to the Glacial clay? So far from limiting my meaning of a valley to the stream itself, I contend that all the valleys of the East of England, with one or two exceptions, have been formed subsequently to the Glacial clay; but I point out that this clay occupied depressions or erosions of greater or less extent, some of the smaller of which (as in the case of parts of the Roding and Wid valleys), have been incorporated into existing valleys that chance to traverse them, quite irrespective of their original character; and thus give in these parts an illusory impression of the valley having been formed before the Glacial period. I have been especially desirous to call to the attention of geologists the great contrast presented, in this respect, by the valleys in strata newer than the Trias south of Flamborough Head, to those of the same strata north of that point.

In reply to Mr. Green, I beg your readers to compare the section he has given in his letter to you with that which he gives in the Memoirs of the Geological Survey for sheet 45 (which is that objected to by me in my paper), and judge for themselves what similarity there is between them, for there appears to me to be scarce any. If the suppositious (or dotted) line be omitted, I see little in his section sent you to object to, beyond its incompleteness; and I ask your readers to judge what ground it affords for the assertion, made in reference to the section given in Memoir 45, across the Ouse, "that a valley existed in the stratified rocks, previous to the deposition of the drift, which has been filled up with gravel, and then partly hollowed out again."[1] I subjoin a section shewing what I submit to be the true structure across the Ouse at Buckingham. In it I represent the Great Oolite and Cornbrash as presenting an eroded surface to the Glacial beds, which I submit to be the cause of those features attaching to the Cornbrash upon which Mr. Green relies. The irregularity of the Pre-glacial surface is indicated by the outcrop at Lillingstone Dayrell, of the older rocks, without the intervention of the bed No. 2, the gravel; that bed coming in again in great force under Whittlebury, three miles beyond the northern end of my section. It is impossible that the Post-glacial valley system should not frequently encounter these irregularities of Pre-glacial surface, which are thus made use of to found an argument for the Pre-glacial origin of our present valleys in the South. The main charge that I bring against this part of Sheet 45, and the Memoir accompanying it, is that both omit all reference to that which, having regard to its superficies and original thickness, is the greatest Tertiary formation of England, in point of magnitude—the Glacial clay. But few of your readers may be aware that, although the gravel given in Mr. Green's section is copiously illustrated, and this, as well as the valley beds, and even the alluvium, are described in the memoir, not the least allusion, either in map or memoir, is made to the Glacial clay. The result is that, not only this part of Sheet 45 E, but the greater part of Sheet 52, nearly half of Sheet 46 W, and part of Sheet 53, are delineated in a merely conjectural manner. Had this great formation not been thus ignored, I cannot conceive that the Geological surveyors would have failed to recognize that the valley of the Ouse, from the source of that river above Buckingham to its debouchure upon the Fen country, was, as Mr. Prestwich had shown it to be about Bedford, formed subsequently to the Glacial clay.

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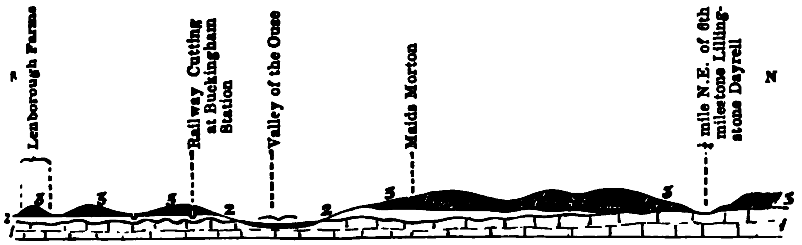
[1] Memoir for sheet 45, p. 34.


S
Lenborough Farms
Railway Cutting at Buckingham Station
Valley of the Ouse
Maids Morton
½ mile N.E. of 6th milestone Lillingstone Dayrell
N
3
3
3
2
2
3
3
3
2
1
1

1. The Great Oolite and Cornbrash concealed except where the valleys cut down to it. 2. Gravel and sand with boulder beds (the Middle Glacial), being bed No. 1, of Mr. Green's section. 3. The Upper Glacial clay —— Valley deposits, alluvium, etc. N.B. The Oxford clay may come in at the South end of the section under No. 2, but if so it is wholly concealed.

The junction-line of 2 and 3 should be level instead of undulating as made by the engraver on one side of the Ouse.

Base-line about 200 feet above the sea. Vertical scale about 500 feet to the inch. Length of section six miles.

S. V. Wood, Jun.

P.S.—In his letter Mr. Dawkins says, in reference to the brick-earths in the Railway cutting immediately to the North of Mile-end Terrace, and half-a-mile from Hill-house (which I have mapped as a part of the Dartford-heath brick-earth, and treated as identical with those of Crayford, Erith, and Ilford, which Mr. Dawkins regards as synchronous), that "the fact that they contain nearly all the testacea now living in our rivers, and none of those extinct

in Britain, and no bones of mammals, proves them to be much newer than the neighbouring deposits containing older forms of life." Now, since writing you I have heard from Mr. Prestwich that he found the land and freshwater shells of the Erith beds in this cutting in the year 1850 or 1851, and among them, he thinks, the *Cyrena fluminalis.* Mr. Whitaker, also writes me, in reply to my enquiry, that he thinks he found the *Cyrena* in the cutting West of Dartford Station some years ago, but cannot speak with any certainty, not having his note books of that date with him.
S. V. W., Jun.

SUBAËRIAL DENUDATION.

Sir,—I did not intend to answer communications objecting to arguments and statements in my paper; but one of the letters in your last number demands a few words.

I am sorry that I should have misrepresented the views of my friend and colleague, Mr. Hull, and thereby given him any annoyance; but, at the same time, I am glad that the name of another able and tried geologist may be added to the roll of those who allow that great things have been done by subaërial denudation, though he does not go so far as some of us.

I read his letter on "River-Denudation of Valleys," soon after it appeared (Geological Magazine, Vol. III., p. 474) but did not refer to it in my paper, as it seemed to me to uphold marine rather than subaërial denudation. My mistake arose from taking certain statements of Mr. Hull's, which had reference to some valleys of a certain sort, as applying to valleys generally.

I have not seen his paper in the "Popular Science Review," and I do not hold myself bound to wade through journals of that kind, in search of original articles on geology.[1]

There is another geologist to whom justice was not done in my paper (p. 450)—the Rev. O. Fisher, who, I believe, first published the second of those arguments against the marine formation of escarpments that Sir Charles Lyell admits to be unanswerable (p. 449).

The remarks of your correspondents seem to me to divide themselves, for the most part, as follows:—(1). Some show that, as might be expected (man being fallible), I have overlooked sundry small matters; (2) some make statements of a kind that I have not denied or objected to at all; (3) some have been already answered in my paper; (4) some are simply exceptions to rules that I have stated to be *general, not universal* (and according to the old proverb "the exception proves the rule"); (5) some are founded on a strange misunderstanding of the arguments of subaërialists; (6) some are statements that I cannot agree to, and which I can only meet by denial: none materially weaken the arguments in favour of subaërial denudation.

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[1] Mr. Hull's criticism (Geol. Mag., Vol. IV., p. 567,) of a sentence in the first part of Mr, Whitaker's paper, "On Subaërial Denudation," (p. 453) should have been omitted, as the sentence objected to was corrected at the end of second part (p. 498), a month before Mr. Hull's letter appeared—by the insertion of the word "us," after "follow" (line 15, p. 453).—Edit.

That I do not take up the matter in detail is owing, not to inability to defend my position, but to a wish to steer clear of controversy.

W. Whitaker.

P.S.—(1.) Please insert the following corrections of the second part of my paper which appeared in your November number.[1] Page 485, fig. 1, the *c* should have been at the top of the cut. Page 489, fig. 2. The woodcut does not quite agree with the description. The *broken* lines, above what should have been a firm line on the right and a broken one on the left, but which is continuous and somewhat shaky throughout, ought to have been *dotted*.

(2.) In a notice of my "list of Wells and Borings" (p. 510) the reviewer has mistaken the thickness of the surface-deposits, gravel, etc., given therein, for the depth of the wells. Instead of fifty feet being the greatest depth, some of the wells go down eight times that amount.

I take this opportunity of asking all who have notes of wells and borings in the London district, to favour me with a copy of them, such information being very useful to the Geological Survey.—W.W.

RESEARCHES IN BRITISH MINERALOGY.

Sir,—Your last number (which my absence in Spain has prevented me receiving before now) contains a letter from Mr. T. Davies, dated from the British Museum, in which, after referring to some remarks contained in a late paper of mine (Researches in British Mineralogy, Phil. Mag. Nov. 1867), he states that true Silver-fahlerz, or Polytelite, is "found in quantity in this country and mined for the silver it contains."

Being at present occupied in the preparation of a work on British Mineralogy, this information was very acceptable and at once induced me to visit the British Museum, in the full expectation of finding so valuable and interesting a British mineral species displayed in case No. 11; unfortunately I could not perceive any such specimen labelled as Silver-fahlerz, or Polytelite, nor any notice of its occurrence in the official guide to the collection.

In hopes, therefore, of eliciting further information I send you these remarks:—

Tetrahedrite in general contains more or less silver, but can only be termed Silver-fahlerz, Weissgiltegerz, or Polytelite, when it contains a notably large amount of that metal, say a minimum of over 5 per cent., for some specimens contain even more than 30 per cent. silver. The external appearance and physical character of this species, do not differ so considerably as to enable the argentiferous or non-argentiferous varieties of Tetrahedrite to be with certainty distinguished from one another. Although the former is generally found to be more brittle, lighter in colour and streak, and to possess a higher specific gravity, chemical examination can alone decide conclusively as to whether a grey copper ore is entitled to the name of Polytelite, or not.

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[1] Unintentionally omitted from the December Number.—Edit.

The Foxdale mineral described and analysed by me is a true Polytelite; it contains nearly 14 per cent. of silver (or about 4500 ounces to the ton), and agrees in all its physical characters with the most characteristic specimens of this mineral.

Quite prepared to admit that Polytelite may exist in quantity in the Silver Vein Mine near Lostwithiel, Cornwall, I must, however, confess that some of Mr. Davies' remarks rather tend to raise a doubt in my mind as to this being in reality the case.

Mr. Davies states he knows of "no accurate analysis having been made of this ore," but informs us that "the last sample sold contained 36½ ounces to the ton," and that some years back "the average yield of silver was 68½ ounces to the ton;" and lastly, as something remarkable, states that in one instance it was "214 ounces!"—Expressed in percentages these figures would merely be about 0·11–0·21 and 0·64 per cent. silver—amounts which, mineralogically considered, may be regarded as but traces of silver, not at all conclusive of the presence of Polytelite in the ore.

Metallurgists would not regard such ores as silver ores, but only as argentiferous copper ores; and many of the argentiferous copper ores imported from South America contain far more silver than even the richest of these, yet frequently do not contain a trace of Polytelite.

When, however, Mr. Davies adds that this "silver vein was formerly worked for the rich deposits of silver it contained, I suppose in the state of sulphide"—does he not at once awaken a suspicion that the silver percentage of these ores may, in reality, be due to other sources than to the presence of Polytelite in quantity.

When next in Cornwall, I shall be delighted to avail myself of any opportunity of visiting this mine; and could I procure an authentic specimen of the mineral in question, should have much pleasure in analysing it. Previous experience has, however, taught me how little confidence can be placed in the genuineness of specimens purchased of Cornish minerals, and I have no doubt but that Mr. Davies' experience will have led him to the same conclusion. Accurate mineral analyses requires such an amount of time, skill, and expense, that before undertaking them it should be ascertained with the greatest care whether the mineral in question is an authentic specimen, or not DAVID FORBES.

11, YORK PLACE, PORTMAN SQUARE, W.,
December 23rd, 1867.

BRITISH FOSSIL CYCADS.—Mr. W. Carruthers being engaged in investigating the structure of these fossils, would be obliged for information respecting specimens from any British locality which would enable him better to prosecute his enquiries. He reserves the examination of the foliage to a future period, confining himself for the present to the stems and fruits. Communications may be addressed to him at the British Museum.

THE
GEOLOGICAL MAGAZINE.

No. XLIV.—FEBRUARY, 1868.

ORIGINAL ARTICLES.

I.—A Notice of the Chemical Geology of Mr. D. Forbes.

By T. Sterry Hunt, F.R.S.

THE Geological Magazine for October last contains a criticism by Mr. David Forbes of certain views put forward by me in a lecture delivered before the Royal Institution of Great Britain on the 31st of May, 1867. Of this lecture a short-hand report appears in this Magazine for August,[1] besides which a condensed report, revised by myself, is published in the proceedings of the Institution, in the *Chemical News* for June 21st, and in three French translations in the *Revue des Cours Scientifiques*, *Les Mondes*, and *Cosmos*. The *Chemical News* for October 4th contains a criticism of my lecture by Mr. Forbes, to which I have replied in a communication recently addressed to that Journal.

In the lecture in question, I endeavoured to bring together the results of modern investigations in physics, chemistry, mathematics, and astronomy, and to construct from them a scheme which should explain the development of our globe from a supposed intensely heated vaporous condition down to the present order of things. I could not pretend to discuss, from their various stand-points, all the conclusions arrived at by different investigators, inasmuch as, even had my attainments permitted, the limits of an hour's lecture would have proved far too short.

In regard to the structure of the earth I alluded to two views, one of which supposes a liquid globe covered with a thin crust of solidified rock, generally estimated at from twenty to thirty miles in thickness; while the other regards the earth, if not solid to the centre, as having a crust at least several hundred miles in thickness, and of such solidity and rigidity as to be, so far as superficial phenomena are concerned, inert as if in a solid state. To this latter view I incline; and I cited in support of it the conclusions of Hopkins from the phenomena of precession and nutation, the investigations of Archdeacon Pratt on the crushing effect of immense mountain masses like the Himalayah, and the deductions of Sir Wm. Thomson from the phenomena of the tides, showing the great rigidity of the earth, as so many concurrent evidences that our planet, if not actually solid to the centre, has a crust far thicker than can be accounted for by the theory of a liquid globe covered only with a crust resulting from superficial cooling. This latter view, which was deduced from the increase of temperature observed in descending into the earth, is in conflict with the various mathematical and physical considerations above noticed, and it becomes necessary to revise the older notions of the conditions of a cooling globe.

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[1] See the lists of *Errata* in this Magazine for September, p. 432, and October, p. 478.

The investigations of Charles Deville, and of Delesse, as well as the earlier ones of Bischof, show that the density of fused rocks is very much less than that of the crystalline minerals of which they are composed. From this we may naturally conclude that the crystalline compounds which would separate by slow cooling from a bath of molten rock would gravitate towards the centre, as Saemann has already justly observed (Bull. Soc. Geol. de Fr., Feb. 4th, 1861). In opposition to this view, Mr. Forbes appeals to the results seen in a small scale in the cooling of melted metals, etc.—where a crust forms over the surface. It must, however, be considered that the conditions presented by a small vessel full of a liquid congealing in an atmosphere greatly below its own temperature, and having a crust growing out from and supported by the sides of the vessel, are widely different from those of a liquid globe slowly cooling beneath a very dense and intensely heated atmosphere. In such a case, with a bath of materials similar to those forming our present rock-crust, the crystalline minerals which have been shown by Deville to be from $\frac{1}{7}$ to $\frac{1}{16}$ heavier than the liquid mass; these, as they separated, would sink as naturally as the crystals which form at the surface of an evaporating basin of brine. The analogy holds good, since the denser crystals formed at the surface, whether by evaporation or by cooling, obey the inevitable laws of gravity.

Mr. Forbes next proceeds to some considerations drawn from the mean density of the earth, which, being about 5.3, is twice that of the average specific gravity of the solid materials known at the surface. Admitting that a solid crust of specific gravity 2.65 were to form at the surface of a liquid of density 2.3, and in obedience to natural laws, to sink therein, our critic conceives that, in its descent, it would meet with a denser liquid stratum. He supposes a liquid globe "becoming rapidly denser in descending, as the pressure increased by the superincumbent column of liquid matter;" and he tells us, in a note, that we may admit a density of "nearly 10.7 for the middle zone, and about 18.8 for the centre" (p. 435). Two pages further on he has completely changed his mind, for he tells us that "experimental research tends to show that a limit is soon reached beyond which the compression, or increase of density, becomes less and less in relation to the force employed;" and concludes that there are strong reasons for believing that the central parts of the earth "must consist of much denser bodies, such as metals and their metallic compounds,"—which he further on explains may mean "dense sulphids."

To which of these two views does Mr. Forbes mean to hold, that of a rapidly and constantly increasing density from pressure, or that in which, limiting the condensing effect of pressure, he seeks to explain the density of the earth by a nucleus of heavy metallic compounds? The latter is seemingly an after-thought of the critic, suggested by some notion of the principle involved in the augmentation by pressure of the fusing point of bodies which expand in melting. As was shown by James Thomson, the effect of pressure upon ice (and naturally upon such metals and metallic alloys as, like it, contract in melting) would be to reduce its melting point, a fact which has been experimentally established for ice. Reasoning from the same principle, Sir Wm. Thomson deduced the conclusion that a reverse effect should result from pressure for all such solids as expand in melting; that is to say, that their points of fusion would be raised, a conclusion verified by the experiments of Bunsen, and by those of Fairbairn and Hopkins. From some apparent irregularities in these results, and from the fact that certain of the substances submitted to experiment were bodies of the carbon series, which Mr. Forbes calls "organic," he argues against the conclusions which depend upon a well-defined physical law. In the case of the fusible alloys tried by Mr. Hopkins, it is to be remarked that most of these bodies, like ice, expand in cooling, and consequently *should not have their melting points raised by pressure.* For the memoirs of James and William Thomson, see Trans. Royal Soc. Edin., xvi. part 5, and L. E. D. Philos. Mag., [3] xxxvii. 125. A simple and popular

ition of the principle, and of Mr. Hopkin's argument therefrom, for the
ty of the globe, will be found in the fourth of Tyndal's lectures on *Heat as a*
of Motion. See, also, Sorby's Bakerian lecture for 1863, cited farther on.
Forbes must consider that just so far as he admits the condensing power of
ressure of the superincumbent mass, he increases the difficulty of maintaining
rocky mass in a liquid state.

e condensing effect of pressure was by Dr. Young estimated to be sufficient
duce a mass of granite at the earth's centre to one-eighth its bulk at the sur-
which would give to the earth a mean density equal to twelve or thirteen
that of water. This consideration has led a recent writer in the *London*
naum to conclude with Herbert Spencer, that our earth and the other planets
be only shells of varying thicknesses, enclosing a central cavity filled with
eous matter, by which hypothesis we may explain their apparently feeble den-
. See Mr. Spencer's essay on the Nebular Hypothesis in the *Westminster*
w for July, 1858. It may be observed that his view, which supposes conden-
n to have resulted in the formation of a solid shell around a gaseous nucleus,
t incompatible with my scheme, which is simply opposed to a liquid interior.
also the note of Mr. Barkas, in this Magazine for September last, page 426.
ing Mr. Forbes to settle these vexed questions, we may remark that in case
ppose condensation of the gaseous globe to have commenced either at the
re, or around a gaseous nucleus, it is probable that solidification from pressure
t have taken place long before the liquefaction of earthy matters was complete.
t if we adopt Mr. Forbes's second hypothesis, either that pressure would not
rially augment the density nor raise the melting point of the fused mass, what
nds has he for assuming, as he does, that there occurred a separation of the
d into zones of different densities? That metallic sulphids could be formed at
levated temperature, by condensation from an atmosphere containing an excess
xygen, is contrary to all that we know of chemical affinities; sulphurous acid
metallic oxyds would be the results so soon as the temperature fell below that
issociation. As for the noble metals, whose compounds with oxygen are de-
posed at elevated temperatures, their great volatility, as compared with earthy
metallic oxyds, would keep them in the gaseous form till the last stage of pre-
ation of earthy oxydized matters, when by far the greater part of the globe
probably solidified. Hence we now find them in the earth's superficial crust,
ad of being, as Mr. Forbes would suppose, carried to the centre of the planet.
dging from what we know of chemical affinities, and of the proportions of
elements now existing in the superficial parts of the globe, we cannot conceive
hing else than the production of a homogeneous oxydized silicated mass, upon
h, at a late period, would be precipitated the noble metals. From this mass,
e yet liquid, there might take place a separation of various crystalline compounds,
process analogous to that by which pure lead separates from the bath of the
ntiferous alloy in Pattison's process, as Fournet has already suggested (Geol.
nnaise, 1862, page 398). The last congealed and lighter portion of our globe,
which alone we have to do, was, probably, a sort of mother-liquor from
h, during its slow cooling, compounds of various constitution and density may
have crystallized. In furnace operations, it is true, we may obtain, besides
ated slags, a dense stratum of reguline metals, sulphids or arsenids on the one
d, and a lighter one of saline sulphates or chlorids on the other. But neither
hese classes of compounds was possible in the cooling globe, the reguline
ters for reasons just given, and the saline compounds, for reasons yet to be ex-
ned.

have in my lecture set forth that the earth's superficial crust must have been
posed of silicates of the metallic, earthy and alkaline bases, surrounded by a
se acid atmosphere of hydrochloric, sulphurous and carbonic acids, besides
ery vapor, nitrogen and oxygen. These chemical combinations are such as
ld naturally result from the affinities brought into play at the elevated tempera-
s then prevailing, in virtue of which all those elements capable of forming fixed
stable compounds with oxygen would be precipitated as oxyds. In these con-
ons, as already said, no metallic sulphids would be formed, and the whole of
sulphur would be found as sulphurous acid. In like manner the production of
line chlorids under such conditions, is inconceivable, since in the conjoined
ence of oxygen, hydrogen, and silicon or silica, an alkaline silicate and hydro-

chloric acid would result. Even if, as Mr. Forbes supposes, chlorid of sodium were to be formed in the heated atmosphere, it would be precipitated into a bath of fused silicates, covered by an intensely heated atmosphere containing water, or mingled oxygen and hydrogen gases, and would immediately undergo the same decomposition that takes place when the vapors of common salt are diffused through a potter's kiln, or, as in Mr. Gossage's new soda-process, are passed with steam over red-hot flints. In both cases silicates of soda are formed with separation of hydrochloric acid.

These considerations lead to the conclusion that after all the more fixed elements were precipitated, the whole of the chlorine would finally remain in the partially cooled atmosphere as hydrochloric acid, and the whole of the sulphur as sulphurous acid, together with a large proportion of oxygen, since we find this element in the form of sulphate and not as sulphite in the sea-waters. Mr. Forbes does not, it seems, believe that an excess of oxygen could exist in an atmosphere highly charged with sulphurous acid; and elsewhere (in the *Chemical News*), he tells that it is, "if not impossible, at least highly improbable, that such a heated atmosphere containing sulphurous acid, hydrochloric acid, with oxygen and aqueous vapor, could exist," the elements being in his *opinion* incompatible. He is aware that at certain temperatures sulphurous acid and oxygen unite, in the presence of water, to form oil of vitriol, but he forgets that at a higher temperature this compound is again resolved into water, sulphurous acid and oxygen; and that one of the best processes for preparing the latter gas on a large scale is by this decomposition of sulphuric acid, and the subsequent removal of the sulphurous acid from the cooled gaseous mixture. In the *opinion* of Mr. Forbes, as set forth in the *Chemical News*, the sulphurous and hydrochloric acids would decompose each other in the presence of watery vapour (though every chemist's experience teaches him the contrary); another reason for holding that my supposed atmosphere was impossible. Unfortunately for his *opinion*, however, it happens that large quantities of precisely such an atmosphere are disengaged from various volcanic vents. To cite one among many examples examined by Charles Deville and Leblanc (Ann. de Ch. et Phys [3] lii. pp. 5-63), a *fumerolle* of Vesuvius yielded in June, 1856, a mixture of highly heated steam, hydrochloric acid, sulphurous acid and air containing 18.7 per cent. of oxygen. The sulphurous acid was equal to 2.6 per cent. of the air, and the amount of hydrochloric acid was about five times as great. Traces of sulphuric acid were found in the water condensed from this steam, doubtless formed by the slow combination of the sulphurous acid and oxygen; and I may state for the information of Mr. Forbes, that it was doubtless by a similar reaction that the sulphurous acid became eliminated from the primeval atmosphere. We have here, I may remark, an illustration of the fact upon which I have elsewhere insisted, that volcanoes reproduce, on a limited scale, the conditions of the primeval earth, not only in their solid but in their gaseous products.

Mr. Forbes next asserts that, according to my view, "the hydrochloric acid primeval atmosphere was derived from the mutual re-actions of sea-salt, silica, and in the water" (page 438), and then charges me with the folly of "supposing the pre-existence of compound bodies in a case where he had previously informed us that there were only dissociated elements engaged." Mr. Forbes knows better than this, or at least did know better when he wrote his criticism on my lecture in the *Chemical News* of Oct. 4, for he here quotes my own words, when, in describing the cooling globe, the conditions through which it must have passed, and the affinities brought into play, I say the products must have been "*just what would now result if the solid land, sea, and air were made to react upon each other under the influence of intense heat.*" It is so difficult to characterise properly such a wilful perversion of an author's words that I must leave the task to my readers. What follows in Mr. Forbes's paper as to chlorids, etc., I have already discussed and disposed of. The theory of the constitution of the solid globe next put forward by Mr. Forbes, borrowed from Phillips, Durocher, and Von Waltershausen, is also, as I conceive, met by the argument in the previous pages. When, however, he comes to the atmosphere surrounding his primitive globe, Mr. Forbes puts forward a scheme which is strikingly original. He supposes around the "solidified crust," a dense vapour consisting chiefly of chlorid of sodium, "above this a stratum of carbonic acid gas, and then of water in the form of steam, whilst the oxygen and nitrogen would be elevated still higher" (p. 439), probably, also, separated in the order of their densities. In explanation of this order, he tells us in a note that the zone of carbonic acid gas would be heavier than that of steam, and should, therefore, come below it. But he forgot that oxygen and nitrogen (or atmospheric air) are also both heavier than steam, and should, consequently, be placed *below* the zone of watery vapor. The specific gravities of carbonic acid and steam are respectively 1.525 and 0.624, air being 1.000. But, apart from this absurd mistake, what shall be said to a man who ignores completely the laws of the diffusion of gases? Will Mr. Forbes kindly explain why, in our present atmosphere, the same elements, namely, oxygen, nitrogen, carbonic acid gas and watery vapour, are commingled, instead of being, as he would have them, arranged in separate zones?

I have said in my lecture that the first ocean waters would hold in solution salts of alumina and the heavy metals, all of which would be precipitated before the separation of carbonate of lime commenced. In such events, says Mr. Forbes, "*geologists, though as yet unsuccessful in doing so, might still hope to find beds of alumina* or of the metallic oxyds or carbonates alluded to, in the older strata. *As no beds of such character are known to occur in nature.*" he regards my view with distrust. *Known* to Mr. Forbes! Has he never heard of beds of emery, which are chiefly crystalline alumina, and which occur in the crystalline limestones of Asia Minor, and in the old crystalline schists of New England? Is he ignorant that the beds of bauxite, so abundant in the Mediterranean basin, and used in the manufacture of aluminium, consist chiefly of hydrated alumina? To console Mr. Forbes, however, I will say that I believe these beds of emery and of bauxite to have been formed by secondary and subsequent reactions, and that we have nowhere exposed to view the first-deposited beds, which are everywhere destroyed or buried under more recent strata. When he remembers that the oldest known series of rocks, the Laurentian, consists of quartzites, limestones, and gneiss, evidently of sedimentary origin, and derived from still older sedimentary rocks, he will understand why he cannot hope to discover the first deposits of alumina or metallic oxyds. These, however, in most cases, have doubtless, by mechanical sub-division, or by solution, been subsequently diffused, and enter into the composition of later rocks.

In a note to this paragraph, Mr. Forbes inquires what became of the sulphurous acid of the early atmosphere: as I have already told him, it doubtless became changed into sulphuric acid and passed into the sea. He then says, "it may safely be asserted that there is fully as much (if not more) sulphur than chlorine" in nature, and that according to my hypothesis the sea would become a solution of sulphate of soda. Very *safely asserted* indeed, since Mr. Forbes takes care to tell us that the sulphur in the form of dense metallic sulphids went to the centre of the earth, which I have shown, I think, good reasons for not believing. As it is, we have only to consider the quantities of sulphids and sulphates in the rocks and waters to see the absurdity of his remarks.

He next proceeds to discuss the theory of the origin of carbonate of lime. I have said that with the exception that derived from the subærial decomposition of primitive calcareous silicates, all the carbonate of lime of the earth's surface has been formed from the decomposition of the soluble lime-salts of the sea, by carbonate of soda (and other soluble carbonates). I, moreover, lay down the proposition that "animals can only appropriate the carbonate of lime already formed." In the face of these quotations, cited by Mr. Forbes, he says, as if charging me with holding the view, that if limestones were "formed by precipitation, they would have, from the moment of their deposition, a decided crystalline structure," while "Sorby's microscopical researches prove satisfactorily that *all limestones*, from the most ancient up to the most recent, are *solely formed of the debris of organisms*;" this will probably be surprising news for Mr. Sorby, and a decisive blow for those who question the organic nature of *Eozoon*. I am prepared to go as far as any reasonable man in asserting the organic origin of limestones, and have, as every one must see, implied the intervention of organic life, when I say "animals appropriate the carbonate of lime, etc." The question is, however, whence comes the carbonate of lime to supply the wants of these animals? Mr. Forbes delares that "zoologists believe that marine animals can utilize the other salts of lime existing in the ocean," evidently the sulphate or the chlorid of calcium once so abundant there. Will Mr. Forbes or the zoologists explain what has become of the acids once combined with the lime which has built up the thousands of feet of limestone chiefly fossilferous, which are found in the earth's crust? The only plausible chemical explanation is that which I have given, namely—that the chlorid of calcium has been decomposed by carbonate of soda derived from decaying feldspathic rocks, giving rise thereby to common salt and to the carbonate of lime which has supplied the marine animals.

As regards the question on the origin of dolomites, which Mr. Forbes next proceeds to notice, he will do well to consult my paper on the subject in the *American Journal of Science* for July, 1866 ([2] xlii. 49). In this, at §112, he will see that, apart from the formation of stratified sedimentary dolomites, I insist upon the frequent occurrence of dolomite as a mineral of secondary deposition, lining drusy cavities, filling veins, and even the moulds of fossil shells. To such cases the observations of Sorby may possibly refer. I can find no other account of his researches than the brief note in the Proc. of the Brit. Assoc. for 1856, cited by Mr. Forbes. Although I have a great respect for Mr. Sorby as an investigator, I have very little for the old theory of dolomitization of sedimentary limestones. No one who has carefully studied, as I have done for years, the distribution and association of the great beds of dolomite which occur in the Lower Silurian rocks of Canada and New England, can for a moment admit that these are the products of subsequent alteration. Repeated alternation of pure blue limestones with reddish ferruginous dolomites, interrupted beds and patches of these enclosed in the former, the line of demarcation sharply drawn, and finally conglomerates in which pebbles of pure limestone are enclosed in beds of dolomite, are incontrovertible evidences against the theory of the dolomitization of limestones, and in favour of the deposition of dolomites as magnesian sediments. (Geol. of Canada, 1863, p. 612).

Mr. Forbes, in a note, insinuates that I am unaware of the various speculations and theories which have been put forward to explain the supposed origin of dolomite by alteration. Although the stratigraphical relations of dolomite, as described above, completely contradict this hypothesis of its origin, at least in the great majority of cases, Mr. Forbes will find that the observations and speculations of Haidinger, Von Morlot, Marignac, and others, on this subject have been fully discussed and made the subject of multiplied experiments by me in a memoir published in 1859 (*Amer. Journ. Science*, [2] xxviii. 170, 365), and later in the paper quoted above, and that I have shown by many experiments that the action of sulphate of magnesia on carbonate of lime, alluded to by Haidinger and Von Morlot before Harkness or Regnault, does not give rise to dolomite, but to carbonate of magnesia, which remains mechanically intermingled with sulphate of lime and any excess of carbonate of lime.

Mr. Forbes says that some of the results of my prolonged study of certain of the salts of lime and magnesia, which are, for the most part, set forth in the papers just referred to, were considered by me to be worthy of being presented to the French Academy (*Comptes Rendus*, April 22, 1867) although he declares the reactions therein described, to have been for more than twenty years in general application, on a large scale in Great Britain for the manufacture of magnesia salts. Here it becomes difficult to admit the plea of ignorance which suggests itself for most of Mr. Forbes previous errors and mis-statements. I have, in the note to the French Academy, above referred to, pointed out the following facts, discovered by my investigations of the salts of lime and magnesia:—1st. That bi-carbonate of lime, at ordinary temperatures, decomposes solutions of sulphate of soda and sulphate of magnesia, with formation of sulphate of lime and bi-carbonates. 2nd. That from mingled solutions of sulphate of magnesia and bi-carbonate of lime, there separates by evaporation, crystalline gypsum, and, subsequently, a hydrous carbonate of magnesia; the bi-carbonate of this base being, as is well known, very much more soluble than either the sulphate or the bi-carbonate of lime. 3rd. That this separation of gypsum is favoured and rendered more complete by an atmosphere impregnated with carbonic acid gas; and 4th, that mixtures, in due proportions, of precipitated carbonate of lime and hydrous carbonate of magnesia, when gently heated under pressure, and in the presence of water, unite to form the anhydrous double carbonate, dolomite. These are the reactions which I described to the French Academy as *new*, and as forming the basis of a reasonable theory of the origin of gypsums and of dolomites. I now demand Mr. Forbes to make good his bold assertions to the contrary, or to show that any one of them has been employed for the last twenty years in the manufacture of magnesian salts.

Mr. Forbes then proceeds to inform us that "the grand development of magnesian limestones, dolomites, and gypseous beds, really took place in an epoch when numerous air-breathing animals, both vertebrates and invertebrates, lived upon the face of the globe." Is Mr. Forbes aware that a large proportion of the 4750 feet of limestone measured by Sir William Logan in Canada, and constituting the three great limestone formations of the old Laurentian system, is magnesian, and often, through great thicknesses, a pure dolomite; that a large part of the Lower Silurian system, and nearly the whole of the Upper Silurian, from the St. Lawrence to the Mississippi, consists of dolomite, and embraces great gypsum beds; and, finally, that immense gypsum deposits, found at intervals from Nova Scotia to the Ohio, lie at the base of the Carboniferous system, in which latter only are found the *first remains* of air-breathing vertebrates? It is dangerous to generalize from the geology of the British Islands, or of a small part of Europe. Moreover, will Mr. Forbes attempt to demonstrate that at the time when Tertiary gypsums were deposited in the Paris basin, there did not yet remain sufficient carbonic acid in the air to modify its chemical action on solutions of bi-carbonate of magnesia, and give rise to the associated dolomites, which I was the first to discover and to describe in that position?

We now, in the language of Mr. Forbes, approach the question of "the igneous origin of eruptive rocks and of granite in particular." I asserted in my lecture the non-igneous origin of granite, maintaining that "the composition of the fused crust would have excluded free silica," and "that granite is in every case a rock of sedimentary origin, as it includes in its composition quartz, which, so far as we know, can only be generated by aqueous agencies, and at comparatively low temperatures." With regard to the first of these statements, it is to be observed that the primitive crust, holding, as we have seen, in the form of silicates, all the soda, lime, and magnesia which now appear in other combinations, must have been a highly basic rock; moreover, even were it much richer in silica than we can suppose it to have been, there is no reason to believe that free silica, in the form of quartz, ever did or ever could crystallize from a fused slag, such as this primitive rock must have been. Quartz, in the shape of rock-crystal, or flint, when fused, or even when long exposed to a heat much below its melting point, is changed into an isomeric modification of silica, analogous to, if not identical with opal, and distinguished from quartz by a much less specific gravity (about 2·2 instead of 2·65), the absence of crystalline structure, and a much greater solubility in alkalies, and hydrofluoric acid. Silica crystallized in the form of quartz has, it is true, been repeatedly obtained by different reactions, but never hitherto except in the presence of heated water or of watery vapour. Heinrich Rose, to whom we are indebted for a careful study of this subject, records, that Gustaf Rose, having submitted to partial fusion a granite rich in quartz, obtained a glass, or obsidian, in which were enclosed unmelted portions of the quartz, converted, however, into the less dense and more soluble opal-like form. These facts in the history of silica were regarded by H. Rose as decisive against the notion of the igneous origin of granite, which he concludes to be incompatible with the actual state of our chemical knowledge. His paper on this subject, which should be read by every geologist, appeared in Poggendorf's *Annalen* for September, 1859, and a careful abstract of it will be found in the *L. E. and D. Philos. Mag.* for January, 1860 [4] xix. 32). The new view of the origin of granite, which is there cited, as maintained "particularly by Mr. Sterry Hunt," is, that all granite rocks are derived from the alteration of sediments, containing, besides feldspathic or argillaceous elements, quartz, derived, as I have explained, from the action of acid solutions at high temperatures on the primitive crust of silicates.

The geological evidences are multiplied, that gneiss, which does not differ mineralogically from granite, and in its coarser varieties is constantly confounded with it, is the result of the alteration *in sitû* of sedimentary rocks consisting of quartz with feldspathic or argillaceous matters, the debris of pre-existing rocks. Moreover, it is demonstrable that these stratified sediments have been softened, and while in such a condition displaced or extravasated, and have thus taken the form of exotic or eruptive rocks. Having by this or other means lost the mechanical evidences of their former stratified condition, they are called granites. The same view is, according to me, applicable to dolerites, diorites, and trachytes. Modern lavas have no other origin, but take a different form, because they come to the surface, and are rapidly cooled, instead of being slowly solidified under the pressure of superincumbent strata. The fact that every eruptive or exotic rock (with the exception of certain rapidly cooled lavas) has its mineralogical equivalent among indigenous crystalline rocks, that is to say among sedimentary strata of chemical or mechanical origin, is a powerful argument in support of the view here put forward. In connection with this, I have shown that a combination of chemical and mechanical agencies naturally and inevitably leads to the division of aqueous sediments into the two great types to which lithologists refer all eruptive rocks, namely, the acid, granitic or trachytic and the basic, doleritic groups, which are supposed to form the two zones of igneous rock imagined by Phillips, and since insisted upon by Durocher, Bunsen, and Forbes. As all of these crystalline rocks are, according to my hypothesis, ancient sediments, it follows that water has been present among them from their first deposition, and during all the subsequent processes of their heating, softening, crystallization, and ejection,—a view constantly insisted upon by me, and in accordance with the ideas maintained by Scheerer and subsequently by Sorby. This theory of igneous rocks, although suggested by Keferstein in 1834, and by Sir J. F. W. Herschel in 1837, has been elaborated by me in various papers for the past ten years.

See Theory of Igneous Rocks and Volcanos, *Canadian Journal*, March, 1858; Some Points in Chemical Geology, *Quart. Journ. Geol. Soc.*, Nov. 1859; Chemistry of the Earth, *Comptes Rendus*, June 9th, 1862; Chemistry of Metamorphic Rocks, *Dublin Quart. Journ.*, July, 1863; Contributions to Lithology, Part 1, *American Journ. Science*, March, 1864.

In view, then, of my theory of the derived and sedimentary origin of all eruptive rocks, what does Mr. Forbes mean when he inquires whether I am aware of the immense masses "of volcanic rocks (trachytes) scattered all over the face of the globe, which contain abundance of free quartz"? If he will refer to my Contributions to Lithology, just cited, he will find that I have insisted upon the presence of quartz in trachytes, and also upon the fact that such trachytes pass into granites, from which they differ only in structure (*American Journ. Science* [2] xxxvii. 260). The obvious conclusion to be drawn from the presence of quartz in granites and trachytes is, that neither during nor subsequent to crystallization have these rocks been subjected to a temperature sufficiently elevated to alter the quartz in the manner observed by Rose. In the paper last cited, I have devoted two pages to an analysis of the beautiful researches of Sorby on the microscopic structure of crystals, about which Mr. Forbes talks, though evidently without any conception of their geological bearing. Mr. Sorby, (who makes of the cavities partially filled with watery solutions, which occur in many crystals, thermometers which registered the temperature at which these crystals were formed.) concludes that the quartz, mica, feldspar, and tin-stone of the Cornish veins "were deposited from water holding various salts and acids, at temperatures varying from 200° centigrade to a low red heat," about 340°; while, for some minerals from Vesuvius, which present, besides cavities holding liquids, others filled with stony and glassy matters, he deduces a temperature of from 360° to 380°, and concludes them to have been formed "at a dull red heat, under a pressure of several thousand feet of rock, when water, containing a large quantity of alkaline salts in solution, was present, along with melted rock and various gases and vapors. I therefore think," he says, "we must conclude provisionally, that at a great depth from the surface, at the foci of volcanic activity, liquid water is present along with the melted rocks, and that it produces results which would not otherwise occur." (*Quart. Journ. Geol. Soc.* xiv. 483). One of those results, as is evident from the above citation, is the reducing of rocky matters to a *melted* condition at a *dull red heat*, a point to be borne in mind when Mr. Sorby speaks in his paper of *igneous fusion* in this connection. A true igneous fusion of such matters, *without water*, would, as every one knows, require a vastly higher temperature; and I have elsewhere, after Scheerer, described this softening of mineral matters under the combined influences of water and heat, as an igneous fusion.

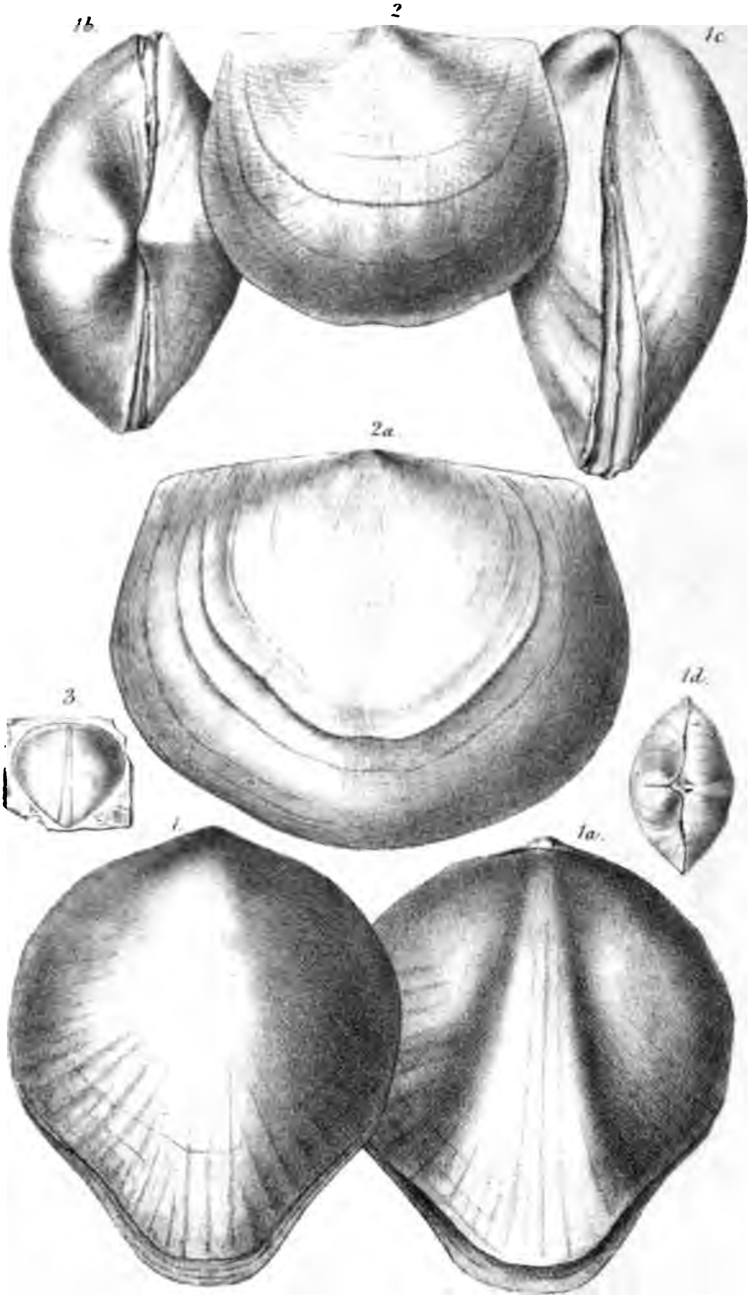
Mr. Sorby has, moreover, calculated the temperature at which the quartz crystals in the trachyte of the Ponza Islands, cited by Forbes, were formed, and finds it to be 360°, they being, in fact, generated under like conditions with those of the quartz of granite veins, from which Mr. Sorby rightly concludes to a similarity of origin between trachytes and granites. That both have crystallized at temperatures not above dull redness, under great pressure, and in the presence of water, is precisely what I have always maintained. When it is remembered that copper, gold, and silver require for fusion from 1000° to 1400°, and quartz a temperature of 2800°, it may not be thought incorrect for me to designate 360°, the highest assigned by Mr. Sorby for the crystallization of quartz, as a "comparatively low temperature," to which expression, however, Mr. Forbes takes exception. Mr. Sorby further concludes from his investigations of crystalline metamorphic schists, that they must have crystallized at about the same temperature as the granites, affording, in his words, "a strong argument in favour of the supposition that the temperature concerned in the normal metamorphism of gneissoid rocks, was due to their having been at a sufficiently great depth under superincumbent strata."

The reader may now judge how far the views of Mr. Sorby, whom Mr. Forbes invokes, differ from my own on the subject of metamorphic rocks, of which I say in my lecture, as quoted by Mr. Forbes, that they have been formed from ordinary sedimentary strata, "depressed so that they come within the action of the earth's central heat," a proposition which our critic thinks "may be disputed." What theory he substitutes, he does not deign to inform us, but proceeds to ask how I explain the depression of strata on the surface of a globe with a solid centre. Both in my lecture and in the papers already cited, I have taken pains to explain that the deeply buried layers of sediment, together with the superficial and water-impregnated portions of the solid nucleus, constitute *a softened or plastic zone*, from which all plutonic and volcanic rocks proceed, and which allows of the movements observed in the solid crust. Is Mr. Forbes aware that geology affords many examples of depression of the earth's surface over great areas, permitting accumulations of sediments, to the extent of 40,000 feet or more, followed by elevation of the yielding crust and denudation to as great an amount?

I here take occasion to call attention to an important consideration in connection with this, deducible from Mr. Sorby's admirable Bakerian lecture before the Royal Society, in 1863, on the Direct Correlation of Mechanical and Chemical Forces, in which he shows how chemical action is produced by mechanical force. Stating from a consideration of the results of Bunsen and Hopkins that those bodies which expand when fused have their point of fusion raised by mechanical pressure, and from the discovery of Sir Wm. Thompson that water, which contracts in melting, has, on the contrary, its melting point lowered by pressure, we may say that as the solution of a solid in a liquid is a kind of fusion, the same general law will hold good, and that, for all those salts which contract in dissolving (to which rule there are very few exceptions), the solubility should be increased by pressure. This was abundantly established by the experiments of Mr. Sorby. If, now, we suppose that the mineral compounds of the crystalline rocks, like most salts, occupy a less bulk when dissolved that when in the solid state, we can understand the greatly increased solvent power of the water present in sediments submitted to a pressure equal to many thousand feet of rock. Moreover, as suggested to me by Sir Wm. Logan, the diminution of solvent power of the liquid as the pressure is removed, will help to explain the deposition of mineral matters from watery solutions, which in their upward flow through fissures in the earth's crust have given rise to mineral veins.

But Mr. Forbes, after considering the conclusion of Sorby that water has played an essential part in the crystallization and softening of rocks, which have been effected at temperatures not above low redness, charges me with "sensation" writing in asserting that the plutonists claimed that igneous rocks were formed "entirely by fire," and accuses me of injustice to the memories of Hutton, Playfair, Hall, Humboldt, and Von Buch, whose writings "show that they never overlooked the all-important influence of water." Now I mentioned none of these geologists in my lecture. As to Hutton, to whom belongs, I believe, the idea of the metamorphic origin of the crystalline schists, I have elsewhere written (*Dublin Quart. Journ.*, July, 1863), "I accept in the widest sense the view of Hutton and Boué that all the crystalline stratified rocks have been produced by the alteration of mechanical and chemical sediments." The question before us is, however, neither the views of Hutton nor yet the origin of metamorphic rocks, but what both he and modern plutonists hold with regard to the origin of granite, whose derivation from metamorphosed sediments neither he nor they admit. With regard to this point Mr. Forbes elegantly says, "*the idea of dry fusion* could only have originated in the brains of their antagonists." Farther, in a note to a paper on th Microscope in Geology, in the *Popular Science Review* for October, he says, wit equal good taste and truth, "*the idea of a true dry fusion in nature* exists only i the brains of the ultra-neptunists or the luke-warm hydrothermalist," and assert that in igneous action the agency of water was always recognized. He alludes t Poulett Scrope, who in 1824 put forth his views on the intervention of water i giving liquidity to lavas; but as Mr. Scrope himself tells us in his late pap (*Quart. Journ. Geol. Soc.* xii. 343), his views were declared to be unchemica discredited, and ridiculed; nor was it till in 1847, when Scheerer published hi remarkable essay on the origin of granites, (*Bul. Geol. Soc. Fr.* [2] iv. 468,) th lithologists began to admit that water had intervened in the generation of granit and other eruptive rocks. But our readers shall judge what value is to be attache to Mr. Forbes's assertions in this matter. After Scheerer's view of aqueo-igneo liquidity had been made known to the Geological Society of France, Durocher, a the champion of the plutonists, maintained in opposition to it, the hypothes already referred to of a separation of the liquid globe into two layers, the low one heavier and basic, the upper lighter and acid, which by its solidificatio gave rise to granite. While he declared that "*Scheerer's new theory* has for i principle the introduction of water in the solidification of granite rocks," Duroch conceived all the water found in eruptive rocks to have been subsequentl absorbed by them (*Bul. Soc. Geol.* [2] iv. 1029, 1032). Rivière, following a secon communication by Durocher on the same subject, declares, "I think wit Durocher, that *water has played no part (n'a joué aucun rôle) in the formation* *granite*," and as to the rocks considered by Scheerer (granites, etc.), he asserts "*t* *geological position of these absolutely excludes the intervention*" *of water* (*Ibid.* [vii. 287). I might further quote Fournet, who in his *Géologie Lyonnaise*, strong maintains similar views to the above, and invokes in favour of his purely igneo theory the results and the statements of Hutton and Hall. Lest, however, the should be any mistake, and that the advocates of dry fusion, Durocher, Rivièr and Fournet, be, after all, ultra-neptunists, I shall cite Elie de Beaumont, who his classic essay on Volcanic Emanations, etc., (published in 1847,) *Bul. Ge* *Soc. Fr.* [2] iv. 1249, has admirably discussed the question before us, giving t views of Fournet and Durocher, the former of whom explains the liquidity of grani by a surfusion of the quartz, which melts at 2800° centigrade, but remains viscid much lower temperatures on cooling; while Durocher, on the contrary, imagin "a sort of fusible alloy" of the various elements, from which the feldspar and mi crystallized. Rejecting these, which he designates as "*purely igneous surfusion*, he declares in favour of Scheerer's "*altogether novel idea*," of a condition of qua fluidity at a low red heat, due to the intervention of water, and asserts that "t hypothesis of a primitive state of *simple igneous fusion of granite*, notwithstandi the evidences brought forward in its favour, is no longer justified" (*loc. cit.* p 1305, 1311). It is in the face of records like these, and despite the energetic pr test of plutonists against the possibility of the intervention of water, and in favo of a dry fusion or a simply igneous fusion of the elements of granite, that M Forbes has the hardihood to assert that the intervention of water in igneous agen "was always recognized by the plutonist."

But I have not done with Mr. Forbes until he shall have shown how, with h own theory of the earth, he explains the intervention of water in all igneo rocks, which, as he declares, are outbursts from the still fluid interior of our glob How did the water find its way there, since, according to him, far above t already solidified crust, this element at first formed a vaporous layer, separat from the earth by a stratum of volatile chlorids and another of carbonic acid ga In virtue of what law did this water, after its precipitation, diffuse itself throug out the various layers of the liquid mass which still fills the centre of the earth, as to be present in every eruptive rock coming up from that great reservoir? F my part, I am inclined to say with Rivière, that the geological position of su matters must "absolutely exclude the intervention of water;" and until M Forbes, or some other plutonist, shall have given a plausible hypothesis to expla the fact, which he admits, of the universal diffusion of water in igneous rocks, prefer my own theory of their origin, namely, that the anhydrous and incande cent nucleus of the globe is solid, and, except in its outer portions, takes no pa in volcanic or plutonic phenomena, which have their origin entirely in the stratifi



del. A. Hollick lith.

W West

Figs. 1_1d, Stricklandinia Davidsoni
Figs 2_2a, S_______ Salteri
Fig. 3. Pentamerus oblongus

sedimentary deposits, and in those superficial portions of the nucleus which were necessarily permeated, during their partial cooling and consequent contraction, by the superincumbent waters.

One word in conclusion: Mr. Forbes, who prides himself on his great opportunities of travel, and on his geological studies in various regions, discourteously taunts me with my own more limited field of investigation. Let me tell him in reply, that if the three papers which he published in October last show any one thing more clearly than his unfamiliarity with geological literature, it is his ignorance of the facts of geognosy, and that he involuntarily recalls to mind the wise saying of Thomas à Kempis, passed into a proverb among churchmen,—"those who make many pilgrimages rarely become saints."

Montreal, December, 1867.

II.—DESCRIPTION OF TWO NEW SPECIES OF STRICKLANDINIA.

By E. BILLINGS, F.G.S., Palæontologist to the Geological Survey of Canada.

(PLATE IV.)

IN the "Canadian Naturalist and Geologist," vol. iv. p. 184, figs. 8–9 (1859), I figured a small specimen of a species of *Stricklandinia* under the name of *S. lens*; but, at the same time, stated that I was not certain whether it was the true *S. lens* or a variety. It was more pointed in front than any of the English specimens I had seen. It had been collected in the Middle Silurian rocks on the Island of Anticosti, along with numerous other specimens, most of them in a fragmentary condition. Among these I thought that *S. lirata* could also be identified; and thus both of the British species have been cited in several of the publications of our Survey.

Through the kindness of the author I received, several months' ago, "Part 2" of Mr. Davidson's "Monograph of the British Silurian Brachiopoda." The clear descriptions and beautiful illustrations of this magnificent work at once enabled me to perceive that we have not (so far as is yet known) either of the two species above mentioned. What I supposed to be *S. lirata*, is the adult of the form figured by me as *S. lens*. The young and small individuals are smooth; but with increasing size and age they become more and more strongly ribbed.

While re-examining the whole collection, with a view to this paper, I broke up several pieces of limestone, which were almost entirely composed of the imperfect and detached valves of another species, and succeeded in getting out several specimens, sufficiently perfect to authorize a description. We have thus two new species; and, as the error with regard to *S. lirata* and *S. lens* has been transferred from my publications into several important English works, it is thought advisable to describe them in the GEOLOGICAL MAGAZINE at once, without waiting for my next report, which cannot be issued for several months.

Stricklandinia Davidsonii, sp. n.—Plate IV. Figs. 1–1*d*.

Spec. Char.—Shell longitudinally ovate; sides and cardinal extremity rounded; front usually with a linguiform extension about one-third of the whole width, and of variable length, sometimes simply narrowed from the mid-length to a rounded point; greatest width about the middle, or a little above. The valves are almost equally convex. The ventral valve has, in young individuals, an obscure mesial sinus, which becomes obsolete with age; towards the front this sinus often gives place to a well-developed fold. Some of the large individuals have neither fold nor sinus in this valve. The dorsal valve usually exhibits a fold, which becomes gradually broader from the beak to the front, where its width is equal to that of the tongue-like projection. The umbones and beaks are so slightly developed as to give only a very moderate angulation to the cardinal extremity. The hinge-line is about one-third or one-fourth of the whole width, and the areas are, in general, concealed by the close approximation of the beaks when the valves are in place; but in separated valves the ventral area is well seen: that of the dorsal valve is linear. In the interior of the ventral valve the mesial septum extends only four lines from the beak in a specimen thirty lines in length; the triangular chamber is apparently two lines in length. In the dorsal valve the socket plates are very short, and not united: they have, as yet, only been seen by grinding down the beak. The small specimens are smooth, or only exhibit faint indications of ribs; but as the shell increases in size the ribs become stronger, although in some of the larger (as in the one figured) they are not very distinct. In general there are three or four ribs running straight from the beak to the front; but on each side of these they curve outwards to the sides. The ribs are rounded, and there are from three to five in the width of three lines at the margin. There are also fine concentric wrinkles, not, however, always visible.

Length of large individuals, three inches; width, varying from nearly equal to one-fifth less than the length. They occur of all sizes from a length of three-fourths of an inch to three inches.

Obs.—Stricklandinia Davidsonii differs from *S. lens*, in being more narrowed in front, more strongly ribbed, and in having the area concealed when the two valves are in their natural position. Notwithstanding the variable form of the shell, there are none, in a collection of nearly a hundred specimens, that could be considered specifically identical with any of those figured by Mr. Davidson in the "Monograph," pl. xix. figs. 14–21. But there is a dorsal valve from the Niagara limestone of Cabot's Head, Lake Huron, exceedingly like fig. 13. It is, however, quite distinct from *S. Davidsonii*, and I think from *S. lens* also.

As before stated the large individuals often have the ribs strongly developed, and curved out to the sides. They thus closely resemble the figure of *S. lirata* in "Sil. Syst.," pl. xxii, fig. 6. Indeed, I could very nearly re-produce that figure from some of our broken specimens. It is these that I thought could be identified with *S. lirata*. The small smooth ones I supposed to be *S. lens*; but, after seeing Mr. Davidson's figures, I re-examined the whole collection, and found that there is a gradual passage from the smooth to the strongly ribbed. The specimen figured (figs. 1–1*c*) is about as perfect as a fossil can be, and is a good example of an intermediate form.

Position and locality.—This species occurs at a number of localities around the coast of the Island of Anticosti, from Jupiter river to East Point. It is most abundant at South-west Point, where the specimen figured was collected. It is associated with *Strophomena rhomboidalis*, *S. pecten*, *S. antiquata*, *Leptæna transversalis*, *Orthis Davidsoni*, *Pentamerus oblongus*, *Spirifera plicatella*, *Leptocœlia* (*Atrypa*) *hemispherica*, *Atrypa reticularis*, and many others, mostly new species. The rocks belong to the Anticosti group, division 3, a horizon which is very nearly, if not exactly, that of the Upper Llandovery rocks. It also abounds on the mainland at the Schickschock mountains, on the south side of the St. Lawrence, about 250 miles easterly from Quebec. I have never seen a specimen from any other part of America.

Stricklandinia Salterii, sp. n.—Plate IV. Figs. 2–2*a*.

Spec. Char.—Shell transversely oval; width greater than the length; sides and front usually rounded, but often with an obscure linguiform extension. Hinge-line nearly as wide as the shell, straight and a little sloping on each side of the beaks. Both valves are gently and uniformly convex. The ventral valve has often a barely perceptible mesial sinus; the umbo small; the beak not incurved; the area very narrow, scarcely exceeding the thickness of the shell; the foramen (as seen in detached fragments) triangular and open to the beak; the small chamber at the beak almost exactly like that of *S. lævis*, and *S. microcamerus*, as figured by Sowerby, M'Coy, and Davidson. The dorsal valve sometimes gives indications of an obscure mesial fold; but, in general, it is uniformly convex. I have not seen the area of this valve, but it must be linear; there is no umbo. Surface with several concentric imbrications of growth, and with very narrow obscure ribs, three or four in two lines, curving outwards to the sides, and some of them upwards to the hinge-line. These are also crossed by fine concentric wrinkles. When the specimens are slightly exfoliated all the surface-characters disappear.

Length of the largest specimen seen, twenty-five lines; greatest width of the same, at about the mid-length, thirty-three lines. Some of the specimens indicate a greater proportional length.

Obs.—There is no other known species with which this need be compared except *S. lævis*, Sowerby, as described by M'Coy, under the name of *Pentamerus microcamerus* (Brit. Pal. Foss., p. 210). The width of that species, in proportion to the length, is stated to be as fifty-five is to one hundred, whereas in this it is, on an average, about eighty to one hundred. This great difference in proportions rarely occurs in the same species. Messrs. Davidson and Salter are of opinion that M'Coy's *P. microcamerus* is identical with *S. lens*. Be that as it may, the figure of *S. lævis*, given by Sowerby in "Sil. Syst.," pl. xxi. fig. 21, seems to be distinct from *S. lens*, and also from *S. Salterii*. He says (*Op cit.*, p. 638), "Semicircular, compressed, smooth; a slight elevation along the middle; beaks rather prominent, the area between them narrow, with parallel edges. Length, eight lines; width, twice as much." The words "elevation along the middle" could only apply to the dorsal valves of *S. lens* and *S. lævis*, in neither of which can the dorsal foramen be seen, when viewed in the position in which Sowerby's specimen is drawn, as it is in the figure cited. This figure, however, always appears to me to exhibit a sinus rather than a fold, in which case it would be a ventral valve. Judging from Mr. Davidson's figures, I should say that the upper part of the ventral valve of *S. lens* must be of a very different form from that of the specimen represented by Sowerby.

Position and locality.—Stricklandinia Salterii occurs at Heath Point and Cormorant Point, Anticosti, in the Anticosti group, division 3 = to the Upper Llandovery rocks.

Besides these two species there is a form with the ribs straight, which may possibly be a variety of *S. Davidsonii.* It occurs at Anticosti in the same beds with the others.

In describing *Stricklandinia* I unfortunately stated that "This genus includes three English species, which have been long known under the names of *Pentamerus lens*, *P. liratus*, and *P. lævis*." I was aware that the *P. lævis* of J. Sowerby was the young of *P. oblongus*, and supposed that the name had become obsolete as to its first application. In that case *Spirifera? lævis*, J. de C. Sowerby, which was a true *Pentamerus*, as the genus was then understood, became *P. lævis*. That this is the one I had in view may be seen by the remark quoted from my Pal. Foss., p. 84, by Mr. Davidson in his "Monograph," p. 158. The sentence is irregular; but it was intended to read thus, "The hinge-line in some of the species, such as in *S. lævis* and *S. microcamerus*, is straight and much extended."[1] This could not possibly apply to the original *P. lævis*, which has no hinge-line at all; but it does apply to the figure of *Spirifera? lævis* above cited. There is not the slightest trace of any of the generic characters of *Stricklandinia* in J. Sowerby's figure of *P. lævis*, and it is impossible that I could have intended to include it in my genus. Several years before I proposed *Stricklandinia* I was under the impression that *P. lævis* was the young of *P. oblongus* from comparing our own specimens, one of which I have figured (Fig. 3); and in 1858 I was informed, I think by Mr. Salter, that it was so regarded in England.

EXPLANATION OF PLATE IV.

Fig. 1.—*Stricklandinia Davidsonii*, ventral valve; 1*a*, dorsal valve; 1*b*, cardinal extremity; 1*c*, side view; 1*d*, cardinal view of a small specimen, with beaks ground off to show the chamber and septa.

Fig. 2.—*Stricklandinia Salterii*, ventral valve, the right-hand cardinal angle restored. 2*a*, ventral valve, both cardinal angles restored.

Fig. 3.—Young of *Pentamerus oblongus*, from the Niagara limestone at Cockburn Island, Lake Huron. When I read the paper on *Stricklandinia* in March, 1859, I exhibited to the Natural History Society of Montreal a specimen just like this, only a little larger, in order to show the difference between *Pentamerus* and *Stricklandinia*.—E. B.

III.—NOTES ON THE GEOLOGY OF THE DOBRUDSCHA, BULGARIA.

By Dr. CHARLES F. PETERS, of the University of Gratz, Austria.

HAVING lately read some interesting remarks on the well-known green-coated flints of Kent in the GEOLOGICAL MAGAZINE,[2] I am induced to offer you the following notes.

During the summer of 1864 I investigated many parts of Bulgaria, but more especially the Dobrudscha, where the sagacious observations of Capt. T. Spratt, R.N., F.R.S., frequently served me as guides. In the highly interesting Cretaceous strata at Kanara, near Küstendsche, which had been correctly identified by Capt. Spratt as Chalk,[3] and from which Professor Reuss lately described many *Foraminiferæ*,[4] I discovered a pseudomorphous substance, which replaces the flint at many points along the coast, and in the Kara-suvalley.

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[1] In the original it is "The hinge-line in some of the species, such as in *S. lævis* and *S. microcamerus*, have the hinge-line straight and much extended."

[2] See Mr. G. Dowker's article, GEOLOGICAL MAGAZINE, 1866, Vol. III. p. 210, see also pp. 223 and 239 in same volume.

[3] Quart. Journ. Geol. Soc. Lond., vol. xiv. p. 207.

[4] Sitzungsberichte, Wiener Akademie, lii. p. 445.

I should mention here, that the Chalk in this country is everywhere overlain by calcareous or sandy beds of Miocene age. The metamorphosed masses consist of a green or greenish-grey soft mineral, which contains many crumbling remains of a flint-like silicious matter, the whole mixed with carbonate of lime. After extraction by acetic acid, the dry substance becomes of a yellowish colour. When analyzed by Dr. Richard Maly, it gave the following composition:—

Silica....................	56·11	Magnesia...............	2·40
Alumina................	26·21	Water	12·00
Peroxide of Iron.......	1.77		

It is, therefore, essentially a hydrosilicate of alumina. Although this mineral much more nearly resembles a chloropal poor in iron than an allophane, the relation of the latter to the Kentish green-coated flints is not so very distant but that we may suppose the process of replacement and the chemical causes were nearly the same in both instances, although occurring in such distantly removed countries.

My paper on the geological and geographical description of the northern part of the Dobrudscha is published in the Transactions of the Academy of Vienna (vol. xxvii.).

The district between the Danube and the Black Sea, known as the Dobrudscha, offers many interesting points in its geological constitution.

The drift-deposits of Bulgaria and Bessarabia correspond with the Hungarian "loess," forming vast undulating plains, which attain a height of from 400 to 500 feet above the sea.

The freshwater deposits of Bessarabia, characterized by *Dreissena polymorpha* and many Cardium-like shells, intermixed with some species well-known in the Austrian loess and recent deposits, are not of Miocene age as Capt. Spratt has supposed,—they are rather truly intercalated in the land-shell marls or loess. This Dreissena-bed probably belongs to the oldest drift-series joining (in the Pontic regions) the upper marls with the true Miocene freshwater deposits, called the "Congeria-beds" by the Austrian geologists, and well characterized by many large species of *Dreissena* or *Congeria*, and *Cardium*. These beds have been observed in many parts of Bulgaria and Wallachia. A Miocene limestone, wholly formed by *Tapes gregaria*, some species of *Cardium*, *Buccinum*, *Trochus*, and a multitude of *Foraminifera*, belongs to the "Sarmatic formation" of Mr. Suess, without a trace of the older Mediterranean or Indian shells.

The Chalk corresponds, by the presence of *Belemnitella mucronata*, *Ostrea vesicularis*, and some *Foraminifera*, with the Chalk of Meudon. A Turonian division probably exists. A yellowish marl, from five to six hundred feet in thickness, occurring in the Babadagh mountains, and many banks along the coast, with remains of *Ostrea* and *Inoceramus* (*Cripsii ?*) but not containing any Rudistes, appears to belong to it. Of the Upper Jurassic beds, a part, containing *Diceras*, *Pterocera oceani*, and some species of *Nerinea*, resembles the Kimmeridge Clay of Besançon, and part containing numerous *Terebratul*[illegible]

Rhynchonella lacunosa, *Ammonites biplex*, *A. tortisulcatus*, and many others, resembles the Carpathian limestone series. These Jurassic beds form a vast table-land, extending probably from the northern Dobrudscha mountains to the Chalk and Eocene hills near Shumla and Varna; and are elsewhere overlain by the before-mentioned Miocene and drift strata.

The geological composition of the Dobrudscha mountains is much complicated. Except a reddish-brown Lias marble of true Alpine character, a well-marked Alpine Halobia shale, and a Triassic bed, resembling the Muschelkalk of Mikultschitz in Silesia, and the calcareous Triassic strata at the Plattensee in Hungary, and containing gigantic specimens of *Spiriferina Mentzeli*, numerous remains of *Terebratula vulgaris*, etc., the older formations in the northern Dobrudscha repeat exactly the Transylvanian series, but without the rich coal measures of the Banatic countries.

Igneous rocks, namely many granite-like masses, a quartziferous porphyry, and a great melaphyre dyke, penetrate this older formation, as well as the Inferior and Middle Triassic strata. In addition to this, I will further state that I am of opinion that the Gneiss and Granite which the Danube touches near the town of Matschin, opposite Galatz, are identical with that through which the river passes at the perilous Iron-gate and in the high countries between Passau and Krems. It will be seen, therefore, that the Dobrudscha mountains, although not more than 1600 feet in altitude, embrace a rich series of deposits representing many types of formations widely removed from one another both in central and western Europe.

IV.—A Revision of the British Graptolites, with Descriptions of the New Species, and Notes on their Affinities.[1]

By Wm. Carruthers, F.L.S., F.G.S., Botanical Department, British Museum.

(PLATE V.)

It is of the first importance in Natural History to adopt a precise, and if possible a received terminology, and strictly to adhere to it. From the very different opinions that have been entertained regarding the nature of graptolites, a curiously mixed set of terms have been employed in their description, some being suggested by their supposed resemblance to plants, others being obtained from their affinities to animals. Discarding these I shall employ the terminology proposed by Allmann and Huxley for the *Hydrozoa*, now generally adopted, asking the reader to take here for granted what I hope presently to establish, that these fossils have their nearest allies in this class, and consequently that the terminology is ited equally to both. As the terms, however, have not yet been enerally introduced into text books, it is perhaps desirable to give efinitions of those that I shall have to use in this paper.

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[1] As the chief purpose of this paper is to describe the new species noticed in the list I supplied to the recently published edition of "Siluria," along with others not referred to there, and to give the reasons for the changes introduced, I shall freely use the communications I made to Sir Rod. I. Murchison, as well as two papers printed by me in the "Intellectual Observer," vol. ix. p. 283 and 365. I may be allowed to refer readers interested in these fossils to these papers and to the note in "Siluria," for observations which are here summarized or entirely omitted.

Every hydrozoon exists under two separate forms, the one the "trophosome" destined for nutrition and growth, the other the "gonosome" for reproduction. As nothing representing the gonosome of graptolites has yet been or is likely to be observed, we omit the terms proposed in connection with it, and define only those applied to the trophosome. The "cœnosarc" is the common connecting basis of the colony, organically uniting the various individuals or "polypites." The soft parts are more or less completely protected by a chitinous "polypary"; to that portion investing the cœnosarc we confine the term "periderm," and the cup-like receptacle in which the individual polypite exists is called the "hydrotheca." The "hydrorhiza" is the root-like termination of the polypary by which the compound hydroid is attached to foreign bodies, and the "hydrocaulus" is the portion of the polypary that intervenes between the hydrorhiza and the first hydrotheca. In the *Sertulariadæ* the "gonophores" or generative buds are produced from the sides of the "gonoblastidium," or column which passes up the centre of the "gonotheca," or "gonangium."[1]

The general structure of the graptolite is very simple. The polypary only has been preserved, and that consists of a periderm sometimes forming a thread-like tube, from which the hydrothecæ are given off at regular intervals (*Rastrites*), or a larger tube, the one face of which is formed of the conjoined bases of the uniserial hydrothecæ (*Graptolithus*, etc.). The back of the polypary is strengthened by a slender solid axis, composed of the same substance as its walls, and capable of separation from the rest of the polypary. The graptolites with a double series of cells have a similar structure, being composed as if of two single-celled forms united along the back of the periderm, as is evident from the forms constituting the genus *Dicranograptus*, in which a double polypary at the proximal end is more or less speedily resolved by division into two branches, with a single series f cells on their outer aspect.

From this definition I exclude several forms which have been eferred to graptolites. First, two remarkable genera of double grapolites representing perhaps different sub-orders,—*Retiolites*, Barr., hich has no central axis, but the two series of cells rise on either ide of a single internal canal which occupies the central portion of he polypary, and *Phyllograptus*, Hall, with a solid central axis, but estitute of a common canal, the plates of the different cells being ontinued to the solid axis. Also, the genera described by Hall and mmons, in which no cells have been detected; and lastly, the retiulated fossils named *Dictyonema*, the affinities of which to graptoites seem to me very doubtful.

The structure I have described is that of the normal members of e order. Before complicating our investigations regarding their odern representatives, by introducing the consideration of the abnormal genera, we must first determine the relations of these abnormal structures to the type structure of the order, which has not yet been done.

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[1] Allmann in Ann. and Mag. of Nat. Hist., May 1864, p. 350.

I am induced to prefix to this revision of the British species a statement of the evidence which induces me to place the graptolites among the *Hydrozoa* at greater length, because of a paper recently published by Dr. Nicholson on this subject (Ann. and Mag. of Nat. Hist., Jan. 1868), which I will not characterise, leaving that to my readers after they have become acquainted with some extracts that I shall require to make from it. Every palæontological student will allow that it is wasting time to imagine the purpose of obscure and anomalous structures, or to discover for them by wild stretches of the imagination fancied analogies with structures in recent tribes to which the writer is anxious to ally them. There must be a correspondence of some kind between the organisms better than a "possibly," a "probably," or even an "apparently." If any trustworthy determination is to be reached, it must not be built upon supposed resemblances about which there must always be a difference of opinion, but upon structural points existing in the fossils that are identical with, or at least similar to, what is found in recent organisms.

All evidence from the cœnosarc and its appendages is necessarily wanting in these palæozoic fossils, and our comparison must be based entirely on the polypary.

Accepting the opinion almost universally entertained, that the cells of the graptolite contained animals living in colonies, the investigation as to their modern allies is limited to the cœlenterate and molluscoid zoophytes. The *general form of the polypary* is not of importance, as on the one hand it is one of the most variable characters in the same group, and on the other, it is one that repeats itself in very different groups. It would be impossible to distinguish between the *Hydrozoa* and the *Polyzoa* from general form; besides, this is very variable amongst the graptolites themselves. Neither is the notion that the *polyparies were free* (granting that they were so) of much significance, inasmuch as there are free forms among both the *Polyzoa* and *Hydrozoa*. Nor can much stress be laid on the *chitinous nature of the polypary*, for though that of the *Hydrozoa* is always chitinous, in "many *Polyzoa* it is horny and flexible" (Busk), and all the species of the order of *Polyzoa* which most nearly resemble the graptolites have such a horny polypary.

While the great systematic distinction between the *Hydrozoa* and the *Polyzoa* depends entirely upon the remarkable difference of the polypites, yet there has been found associated with each class so peculiar a structure of polypary that there is no difficulty in determining to which group a particular polypary belongs. This structure is connected with the presence or absence of a common canal, and with the relations of the cells which contain the polypites to it. The true affinity of the graptolite will be easily determined, when we ascertain to which of these two types of structure it most nearly approaches.

The corallum of the *Anthozoa* differs so widely from the polypary of the graptolite, that this great division of the *Cœlenterata* may at once be excluded. And I do not except from this exclusion the *Pennatulidæ* to which Beck in Murchison's "Silurian System" referred the graptolites. The apparent resemblance between *Diplograpsus* and *Pennatula* or *Virgularia* is very superficial. The three genera may agree in being free organisms, and they have a bilateral arrangement of parts and a prolonged solid axis, but in the fossil the axis is slender and corneous, and is produced at the distal end of the organism, while in the recent genera it is thick and calcareous, and proceeds from the proximal end. The cells containing the animals are dug out of the cœnosarc in *Pennatula* and *Virgularia*, while in the graptolites the polypary is corneous and external. Our comparison will therefore be confined among the *Cœlenterata* to the *Hydrozoa*.

In the same way we may strike off those forms of the *Polyzoa* which have obviously no resemblance to the graptolites. In dealing with this class it is fortunate for the palæontologist (although a matter of regret to the zoologist) that its classification is based almost entirely on the structure of the polyzoary. The freshwater forms and those without a hard cuticular layer may at once by set aside. In both the *Cheilostomata* and *Cyclostomata* the cells are budded from each other, and eventually all living connection between the polypites is cut off, so that in adult specimens no opening has been detected between neighbouring cells. The presence of a canal, common to and opening freely into all the cells, in the graptolite is sufficient to exclude these orders from our consideration. The flat double corneous disc of *Dichograpsus* has only an external resemblance to the discoid calcareous polyzoary of *Defrancia*, and in every other respect the structure of the two genera is totally different. The only order of *Polyzoa* with which the graptolite can be compared is that named by Busk *Ctenostomata*, and by Gray *Polyzoa cornea* from the composition of their polyzoary. The members of this order have a common basal tube on which the individual cells are placed. The base of the cell is cut off from the common tube by a septum, but through this there is a small opening by which the various polypites have a living connection with the circulation and the structures in the tube which are common to all the individuals of the colony.[1] The correspondence in the arrangement of the cells on a common canal in *Vesicularia* and *Graptolithus*, or in *Farrella* and *Rastrites* is very obvious, but the existence of the perforated septum at the base of the cell is an invariable and important character in all these *Polyzoa* which at once distinguishes them from the graptolites.

Professor Huxley in his Monograph of the Oceanic *Hydrozoa*, published by the Ray Society, has grouped the *Hydrozoa* into six orders from the leading modifications in their structure. It is important to us to find that these orders have marked distinctions in the protective coverings of the cœnosarc, and it will enable us to establish a more satisfactory comparison if we give the characters of these orders, as far as they bear upon the parts in the graptolites with which we have to deal.

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[1] Dr. Nicholson summarily dismisses the *Polyzoa* by asserting that they "have, as a rule, a more or less calcareous test, and the individuals forming the compound organism are not united by any organised connecting substance." Perhaps a common circulation in the basal tube is not, in Dr. Nicholson's opinion, an "organised connecting substance," and Gray and Busk may be ignorant of the true nature of the Polyzoan test.

I. *Hydridæ.*—Hydrosoma consists of a single polypite. The ectoderm developes no hard cuticular layer. *Hydra* is the only genus of this order.

II. *Corynidæ.*—Hydrosoma developed into a cœnosarc of very various forms, supporting many polypites without thecæ. The ectoderm developes a strong cuticle. The hydrosoma is fixed by a hydrorhiza.

III. *Sertulariadæ.*—Cœnosarc with a strong, chitinous cuticular layer, which is usually branched, and supports polypites enveloped in thecæ. The hydrosoma is fixed by a hydrorhiza.

IV. *Calycophoridæ.*—Cœnosarc unbranched, flexible, and contractile, and has no hard, chitinous, cuticular layer. The hydrosoma is free, and the polypites have no thecæ.

V. *Physophoridæ.*—Cœnosarc unbranched or very slightly branched, flexible, and contractile, and has no hard chitinous outer layer. The hydrosoma is free, and the polypites have no thecæ.

VI. *Lucernariadæ.*—The base of the hydrosoma is developed into an umbrella. The cœnosarc has no chitinous layer.

There are no parts in the first or in the last three orders which can be compared with graptolites. The members of these four orders are all devoid of any hard cuticular layer. They must therefore be at once set aside, and we are limited to the second and third orders. The *Corynidæ* differ from the *Sertulariadæ* in having no thecæ for their polypites; but the graptolites were certainly furnished with true thecæ. In *Rastrites* the thecæ rise at distant intervals from the common canal, and in some species of *Graptolithus* they are seen to be distinct structures from the epiderm of the canal. The most obvious indications of these that I have seen are in *G. Hisingeri*, in which there is a superficial line precisely agreeing with that which is seen at the junction of the theca and the epiderm of the canal in *Campanularia*, etc. This is figured by M'Coy in his "British Palæozoic Fossils" (Tab. I.B. fig. 7a), and described by him as a septum; but a specimen in my possession, preserved in the round, shows that the line truly belongs to the outer cuticular layer, and is not an internal structure. This excludes from our consideration the *Corynidæ*, and confines us to the *Sertulariadæ.* In this order there is a hard chitinous cuticular layer forming a periderm around the common canal, and distinct chitinous thecæ for the individuals of the colony. In these respects no difference exists between the polyzoary of the *Ctenostomata* and the polypary of the *Sertulariadæ;* but the separation between the cell and the common canal by a distinct structure, which is present in all the *Polyzoa* with a common tube, is absent in the *Hydrozoa.* In them the wall of the hydrotheca is continuous with the periderm of the common canal, and no septum exists separating the contents of the two. This, too, is, as we have seen, precisely the structure of the graptolite; and if there were nothing more to be taken into account, the fossil could not be separated from the *Sertulariad* . But there is an important additional structure always present in the true graptolite—namely, the slender axis; and there is no analogous structure in the *Sertulariadæ*. We cannot well compare this axis with that of the *Pennatulidæ*, even neglecting the nature of its composition, unless we make the whole so-called polypary of the *Graptolitidæ* an endo-skeleton instead of an exo-skeleton; but this would introduce a yet more anomalous structure, for which it would not be possible to find any modern ally.

The comparison, then, that we have instituted between the parts and composition of the polypary of the graptolite and similar polyparies of living organisms, seems to me to establish beyond doubt that this interesting Silurian fossil has its nearest allies in the *Sertulariadæ*, from which it differs in having a solid axis to the polypary.

The complete organism presents some characters that at first sight appear to differ from those of the *Sertulariadæ;* but these differences are not so great as they are sometimes represented. The genus *Dendrograptus* has hitherto been found only in fragments in Britain, but the perfect specimens figured and described by Hall have dendroid polyparies with a strong hydrocaulus terminating in a hydrorhiza. This agrees exactly with the habit of *Halecium*. The other genera of graptolites are generally described as free, but it is remarkable that all of them are furnished with a longer or shorter non-celluliferous portion (radicle of Hall) at their proximal termination. The discovery of more perfect specimens shows that this is very generally present, and that in those specimens in which it had been observed, it is longer than has hitherto been supposed. I figure a beautiful specimen of *Climacograptus scalaris*, Hall (Pl. V., Fig. 9), in which this is produced to a considerable length, and there is no indication that even here we have the termination. The relation of this process to the organism shows that whatever may have been its functions, it is homologous with the hydrorhiza; there is, however, really no reason for supposing that it was functionally different. Hall thinks that the graptolites were free-floating organisms; Nicholson, adopting this, as he does many other things, and, as his practice is, without acknowledgment, is not trammelled by the cautious language of Hall, but asserts that "*there can be no doubt* that the greater number were free-floating or *free-swimming organisms*" (p. 59). And then he finds in the pneumatocyst of the *Physophoridæ* the "best homologue" (*sic*) of the central corneous disc of *Dichograpsus*, and he furnishes the other genera with "possible" swimming bells, which, "*of course*, could never be preserved in a fossil condition"! Finally, to complete the history, "it must suffice to state, that in the simpler genera the secondary cellules appear to be intercalated between the initial point or radicle and the primordial cellule or cellules. . . . . This mode corresponds with that in the . . . . *Physophoridæ*" (p. 58). Unfortunately, however, it only exists in the author's imagination;[1] it is utterly impossible in several genera (*Dichograpsus*, *Cladograpsus*, *Dicranograptus*, etc), and extremely unlikely in all. As all the oceanic *Hydrozoa* of our present seas are entirely destitute of a hard outer layer, and have an excessively contractile cœnosarc, it is "very possible," indeed "beyond doubt," that the Silurian seas were differently constituted to meet the requirements of Dr. Nicholson's hard, chitinous, and non-contractile free-swimming polypary.

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[1] We suppose Dr. Nicholson will allow this, for in a sentence a little before that

I will refer to only one other point in Dr. Nicholson's paper,—it would afford endless material for a persevering commentator,—and to that because it is one which the author has been diligently investigating for some time, and in which consequently he has attained some proficiency. I refer to his "Graptogonophores." In 1866 he published his great discovery, first at the British Association and then in the Geological Magazine for November of that year. He found bell-shaped bodies organically attached by their broad ends to "*Graptolithus Sedgwickii*." These were "gonophores or ovarian vesicles." (Geol. Mag. Vol. III. Pl. XVII. p. 489.) In the February Number of 1867, I suggested in a note on the systematic position of graptolites that if the bodies had anything to do with the graptolite, the specimen as figured by him was turned upside down (*loc. cit.* Vol. IV. p. 71). By the following June he had discovered that he was wrong; but, without taking any notice of his error or my correction of it, he gives drawings of the bodies attached by the slender pedicel to different parts of the polypary (*loc. cit.* Pl. XI. p. 259). In the next Number I pointed out the error of supposing that the ovarian capsules could be borne in the same species on the common cœnosarc, as well as developed from the individual polypites (*loc. cit.* p. 336). At the meeting of the British Association in September last he gave up the origin from the cœnosarc, and in the paper just published in the "Annals" he tries to let himself more quietly down by saying that such an origin "is perhaps accidental;" but during the progress of his knowledge he nowhere acknowledges being indebted for corrections. But now he has established his position "beyond doubt." And this is his last account of the bell-shaped bodies:—"They resemble the gonophores of the recent *Hydrozoa* in being external processes, in some cases permanently attached, in others ultimately detached; the likeness in form is also striking. They differ, however, in possessing a corneous envelope, so that, when detached, they were either simple free-floating organisms, or, if they possessed any independent locomotive power of their own, this must have been obtained by means of cilia or by some soft apparatus which would leave no traces of its existence. It is probable that the capsules did not contain the germs of graptolites as we now find them in a fossil condition, as thought by Hall, but that their contents were the ova in their earliest stages. The ova would probably be liberated, on the dehiscence of the capsule, as

we have quoted from, he tells us that the minute corneous germ he describes is "the primitive structure of the embryo," in imagination, that is, for he immediately adds "it must, *in fact*, be considered very probable that these germs, as we see them, are considerably advanced in growth, and that the earliest form of the embryo was devoid of any corneous test."

minute ciliated free-swimming organisms, which subsequently, and as a later development, acquired a corneous envelope." I would be glad to have some light on this novel mode of reproduction. I confess my inability to understand it. My impression is—but I express it with diffidence—that Dr. Nicholson has somehow confounded the external bell-shaped gonothecæ of the *Sertulariadæ* and the gonophores they contain, and that some clauses in the sentences quoted refer to the gonothecæ and some to the gonophores.

The generic name *Graptolithus* was first employed by Linnæus in the original folio edition of his famous "Systema Naturæ" (1736), for certain natural objects which he describes as resembling, but not being, true petrifactions. Not a single form of the fossils to which the name is now confined had a place in the genus till the twelfth edition of the "Systema," in 1767, and of the eight species recorded there only one is a true graptolite. This he named *G. scalaris*, and quoted for it the illustration and description in his Scanian Travels (1751), p. 147. There can be no doubt that Hall is right in referring this species to that which is generally known as *Diplograpsus rectangularis*, M'Coy. The "Systema" is always, though erroneously, quoted for another species, *G. sagittarius*. Linnæus founded this species on the drawing of a fragment of a *Lepidodendron* in Volkmann's "Silesia subterranea" (1720), part iii., tab. 4, fig. 6, and accurately described it in his short diagnosis. Hisinger, in some unaccountable way, applied the name to a species of the restricted genus *Graptolithus* with which Linnæus's description has not one character in common. This error has passed through all the works on graptolites uncorrected, and has caused the Linnæan generic name to be applied to the species with one series of cells, whereas the only species described by Linnæus had a double series of cells.

The difficulty of confining the original name to one of the various items included in the genus, and especially of applying a word to these organic remains, which its author employed to indicate that the species included under it were imitations of and not real fossils, presented itself to those who after Linnæus studied this group. Nilsson proposed *Priodon*, but as Cuvier had used it for a genus of fish, he altered it into *Prionotus*. This was first published by Hisinger in 1837. Before this (1835), however, Bronn had published the name *Lomatoceras*, but this name had also been previously employed. The original name was restored by Murchison in his "Silurian System" (1839), in a slightly altered form (*Graptolites*) which has been adopted by British authors. A note by Beck on the family was printed in the same work, and he retains the original spelling, in which he is followed by writers abroad. Under this name all the forms described by Hisinger, Murchison, Portlock, Hall, Geinitz, and others, were included.

Barrande first subdivided the genus (1850), by separating two marked forms under the names *Rastrites* and *Retiolites*, and by forming two sections of the limited genus *Graptolithus*,—*Monoprion* for those with a single series of cells, and *Diprion* for those with a double series. M'Coy in the same year gave these sections a generic value, retaining for the first the original name, and proposing *Diplograpsus* for the second.

Barrande, accepting Hisinger's determination, considered the *Priodon sagittarius* of that author the same as *G. sagittarius*, Linn., and so held the species with a single series of cells to be the true Linnæan type of the original genus. He further endeavoured to show that *G. scalaris*, Linn., was a "scalariform" impression of a single-celled species, and, by an oversight which is remarkable in a work specially characterised by the careful and accurate observation that distinguishes all the labours of its illustrious author, he figures a double-celled Graptolite as the "scalariform" impression of two single-celled species, viz. *G. nuntius*, Barr., and *G. Halli*, Barr., as has been already pointed out by Hall. M'Coy, following Barrande and Hisinger, retained erroneously, as I have shown, the Linnæan name for the single-celled forms. Were it not that he has been invariably followed, I would have restored the name given by Linnæus to the only form with which he was acquainted; but this would introduce into the accepted nomenclature so many changes without corresponding advantages, that the strict application here of the law of priority would scarcely be justifiable. To correct to some extent the error, and to make the extent of the acquaintance which Linnæus had with these fossils more obvious, I have substituted for *G. sagittarius*, Linn. (a name which cannot be maintained), that of *G. Hisingeri*, after the distinguished palæontologist who first described the species, but erroneously ascribed to it the Linnæan name.

Suess, in 1851, added the name *Petalolithus* as a synonym to M'Coy's genus *Diplograpsus*. In the same year M'Coy gave the name of *Didymograpsus* to a well-marked group, and in the following year Geinitz applied *Cladograpsus* to the same group. Unaware that this name had been employed, I proposed it in 1858 for a repeatedly branching form which I found at Moffat. While the paper in which I described this and other forms was passing through the press, I learned that Geinitz had used the name: but as I was unable to ascertain to what group he applied it, I permitted the name to stand, in the faint hope that we had independently selected it for the same form. In the same paper I described a new species of *Didymograpsus*, and recorded two other already described species, so that it is perfectly obvious that I applied the name to a different group from that which Geinitz had included under it. In 1867 Dr. Nicholson gave *Pleurograpsus* to be placed as a synonym to my genus *Cladograpsus*.

Salter, in 1861, described a compound form *Dichograpsus* from the Skiddaw slates, similar to some that had already been observed in Canada by Sir Wm. Logan.

Hall has more than any other palæontologist increased our acquaintance with species of graptolites, and added many very remarkable genera. His extensive acquaintance with the perfect and singular specimens that have been found in Canada and the United States have given him a high vantage-ground, which, independent of the care and ability with which he prosecutes his investigations, would demand for his opinions the most thoughtful consideration. An interchange of specimens between Europe and America would be a great advantage to observers in both countries; for while the drawings of Barrande, Geinitz, M'Coy, and Salter, convey as accurate an impression of our European forms as can be given on paper, and those of Hall equally so of the American species, yet it is impossible for students fully to understand the nature of the organisms without their careful examination; we must always on this side of the Atlantic have a defective knowledge of *Dichograpsus*, and the new genera of Hall, until we have an extensive series for examination; and it is to be expected that on the other side erroneous ideas will be entertained regarding our old-world species, from the same cause. Had Hall examined perfect European specimens of the genus *Graptolithus* he would have seen that very few of these could be parts of the remarkable compound forms which he so admirably describes and illustrates in the last Decade of the Canadian Survey.

In 1857, Hall established the genus *Phyllograptus*. In subsequently published papers he proposed several additional genera, some of which are probably not true graptolites. In some he can detect no cell-openings, and *Inocaulis*, which is not rare in our British Silurians, has a solid homogeneous structure very different from that of any graptolite with which I am acquainted. *Dendrograptus* is an interesting form represented in Britain, and his genera *Climacograptus* and *Dicranograptus*, established for forms already known, are well characterised.

This closes the history of the different genera of British graptolites. I shall now give an analytical key to the genera, and proceed to the enumeration of the species, having occupied much more space than I intended with this introduction.

ANALYTICAL KEY TO THE GENERA.

A. Polypary with a single series of cells.	
a. Polypary simple.	
a. Cells free throughout their whole length.	*Rastrites*, Barr.
b. Cells in contact throughout more or less of their length.	*Graptolithus* (Linn.), M'Coy.
b. Polypary compound.	
a. Polypary growing in one direction from the primary point.	*Cyrtograpsus*, Carr.
b. Polypary growing bilaterally and consisting of two simple or double branches.	*Didymograpsus*, M'Coy
c. Polypary growing bilaterally and branching regularly, and furnished with a central corneous disc.	*Dichograpsus*, Salter.
d. Polypary growing bilaterally, irregularly and repeatedly branching and rebranching, and without a central disc.	*Cladograpsus*, Carr.
e. Polypary with a thick common hydrocaulus, and branching irregularly.	*Dendrograptus*, Hall.
B. Polypary with two series of cells.	
a. Polypary with a slender solid axis.	
a. Cells which are true hydrothecæ.	*Diplograpsus*, M'Coy.
b. Cells hollowed out of the common periderm.	*Climacograptus*, Hall.
b. Polypary without an axis.	*Retiolites*, Barr.
C. Polypary with single and double series of cells.	*Dicranograptus*, Hall.
D. Polypary with four series of cells.	*Phyllograptus*, Hall.

EXPLANATION OF PLATE V.

Fig. 1 *a*. *Graptolithus convolutus*, His., showing the free linear cells at the proximal end of the polypary. 1 *b* and 1 *c*. Cells with two spines rising from the mouth.
2. *Diplograpsus mucronatus*, Hall.
3. *Diplograpsus Whitfieldi*, Hall.
4. *Diplograpsus cometa*, Gein.
5. *Dendrograptus lentus*. Carr.
6. *Dicranograptus Clingani*, Carr. 6 *c*. Three cells magnified five times.
7. *Cladograpsus capillaris*, Carr. 7 *b*. Four cells magnified five times.
8. *Didymograpsus elegans*, Carr. 8 *b* and 8 *c*. Two young specimens. 8 *d*. Four cells magnified five times.
9. *Climatograptus scalaris*, Hall., showing the axis produced at the proximal end to a great length.
10. *Climatograptus minutus*, Carr.
11. *Diplograpsus tricornis*, Carr. 11 *b*. Young specimen.
12. *Diplograpsus minimus*, Carr.
13. *Diplograpsus pristis*, His., showing various forms of appendages at the proximal termination.
14. *Rastrites maximus*, Carr.
15. *Rastrites Linnæi*, Barr.
16. *Rastrites capillaris*, Carr.
17. *Cyrtograpsus Murchisonii*, Carr. 17 *b*. Seven cells magnified five times.
18. *Graptolithus intermedius*, Carr.
19. *Graptolithus Clingani*, Carr.

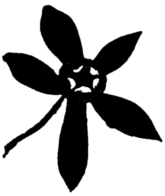
Figs. 1 *a*, 5, and 17 are from specimens in the Jermyn Street Museum; the others are from specimens in the British Museum.

The systematic portion of the paper, and the description of the new species figured in this plate, will be given in next number.

V.—On a Flower-like Form from the Leaf-bed of the Lower Bagshot Beds, Studland Bay, Dorsetshire.

By George Maw, F.G.S., F.L.S.

THE accompanying figure (1) represents a fossil in my possession obtained with some insect remains, by Mr. W. R. Brodie, of Swanage, from the Lower Leaf-bed of the Lower Bagshot beds, Studland Bay, Dorsetshire. It bears a general resemblance to the examples found by Mr. W. S. Mitchell, at Alum Bay and Bournemouth;[1] and to those figured by Heer as *Porana* (Flora Tertiaria Helvetiæ, plate 103), from the Swiss deposits, except in its having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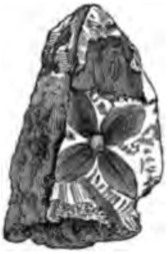
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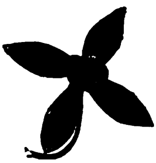
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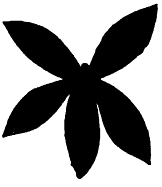
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Fig. 1.—Fossil from Studland Bay. Figs. 2, 3.—*Kydia calycina*, India.
Fig. 4.—*Calycopteris (Getonia) floribunda*, India.

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[1] See Mr. Mitchell's description of *Porana* (?) *vectensis*, etc., in Geological Magazine, 1865, Vol. II. p. 516, figs. 1–3.—Ed.

but four instead of five lobes. It resembles somewhat in outline the recent *Porana volubilis*, and, as the absence of the fifth lobe might be merely an abnormal condition of the individual example, it seemed, at first, scarcely sufficient to separate it from the genus with which all the other similar forms from the Tertiary beds had heretofore been identified.

Mr. Richard Kippist, of the Linnæan Society, has, however, within the last few days pointed out to me the much closer resemblance of the fossil to *Kydia calcycina*, an East Indian plant of the natural order *Byttneriaceæ*, and has furnished me with the recent examples of the enlarged involucre, represented in Figures 2 and 3 for comparison with the fossil. A figure of the plant is also given in Wight's *Icones plantarum Indiæ Orientalis* (vol. iii. table 880, fig. 5). Mr. Kippist remarks that "the fossil agrees far better with *Kydia* than *Porana* in the number and blunt obovate form of the sepals, as well as in the numerous nearly parallel veins, the pointed sepals of *Porana* being penniveined with an intermarginal nerve; in fact, that Wight's figure of the enlarged calyx of *Kydia calycina* is so completely identical with the fossil that the one might almost have been drawn from the other." In the fossil the inner or true calyx with the enclosed capsule appears to have become detached from the involucre (the part supposed to be represented in the fossil), though the broad scar in the centre shows clearly the point of attachment. A large proportion of the examples of *Kydia* have only four lobes to the outer calyx or involucre, but are occasionally found with five, as in Figure 2, or even with six lobes. The Hampshire and also the Swiss specimens figured by Heer vary in this way; and, although the great majority have five lobes, it seems questionable whether the whole are not more properly referable to *Kydia* than *Porana*.[1] Three examples of leaves in my possession from the Corfe leaf-bed, a continuation of that exposed in Studland Bay, agree well with the form and venation of the leaves of *Kydia calycina*.

I submit these few particulars in the belief that the evidence in favour of the affinity of the Tertiary flower-like forms with *Kydia* is equal if not superior to the claims of *Porana* to include them, though the identification of fossil with recent Phanerogamous genera must always be uncertain and difficult. Fig. 4 represents the calyx of *Calycopteris* (*Getonia*) *floribunda*, for which I am indebted to Mr. Carruthers, and which is also more like the fossil than any of the recent species of *Porana*.

NOTICES OF MEMOIRS.

Classification of Meteorites. By M. Daubrée.[2]

The bodies which are comprised under the general name of meteorites have long since been arranged under two great divisions, the *irons* and the *stones*; it is, indeed, the division which appears the most simple and natural. In examining a certain number of these masses it has been thought convenient by some to establish a third, or intermediate division, to which the names of *Mesosiderites*, *Lithosiderites*, or of *Siderolites*, have been given. However convenient may appear this latter division, it presents some difficulties when we examine the passages which connect the extreme terms of the series; viz., from that of massive iron to that of the stone exempt from it. It is thus that certain specimens have been placed by some in the intermediate division, and by others in the third, or in the first division. In not admitting this division there are also difficulties, particularly for the meteorites, such as that of Pallas, where the stony grains are disseminated amongst the metallic mass, and which thus forms the first link between the *irons* and the *stones*. In placing the collection of meteorites in the new cabinet of the museum of the Jardin des Plantes, at Paris, M. Daubrée has replaced the purely chronological arrangement formerly adopted, by a classification which enables one to perceive the relations of this series of planetary bodies.

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[1] See figures of *Porana*, op. cit., p. 516.

[2] Classification adoptée pour la collection de météorites du Muséum. Par M. Daubrée; Comptes rendus des Séances de l'Académie des Sciences, tome 65, July, 1867.

M. Daubrée has adopted four great divisions, to each of which he has given particular names, which, although somewhat new and complicated, are intended to facilitate the study of these bodies.

It is exclusively the solid, or coherent meteorites which are classified, leaving out of consideration the gaseous or liquid matters which may accompany the solid masses, and also the falls of powder which have sometimes been recognised. Metallic iron, which is absent in all terrestrial rocks [?], and is found in nearly all meteorites, has afforded the most natural basis for the great divisions, both as to its arrangement and mode of association with the stony matter, as by its relative proportion. The term *Siderites* is proposed for the meteorites containing metallic iron, and *Asiderites* for those without it. The *Siderites* may be deprived of all stony matter, or contain it in the most minute quantity; these masses comprise the group *Holosidères*, corresponding to the meteoric irons properly so-called; as, for example, the masses of Caille and Charcas. When the *Siderites* contain silicates, the iron may exist as a *continuous mass*, similar to a sponge, the stony matter occupying the vacuities; or the iron may occur in more or less large *grains*, disseminated in the stony matrix. In the first case the *Siderites* belong to the division *Syssidères*; in the second to that of *Sporadosidères*. The *Syssidères* may contain the stony matter in two states, corresponding to those indicated for the iron; either in distinct, disseminated grains, as is observed in the iron of Pallas, in that of Atacama, in that of Tuczon,[1] etc.; or in the form of a continuous mass, entangled as a network with the iron, similar to that of the iron of Rittersgrün. The division of *Sporadosidères* contains the greatest number of known meteorites. For the convenience of study, M. Daubrée has divided them into three sub-groups, under the names of *Polysidères*, *Oligo-*

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[1] The specimen from Tuczon, in the British Museum, presented by the town-authorities of San Francisco, 1863, shows that this meteorite should be classed with the *Siderites*.—J. M.

METEORITES—SOLID AND COHERENT.

Divisions.		Groups.	Sub-Groups.	Examples.	Densities.
I. *Siderites.* Meteorites containing iron in a metallic state	Not containing stony matter	1. *Holosidères*		Charcas	7·0 to 8·0
	Containing both iron and stony matter	Iron in the form of a continuous mass. 2. *Syssidères.*		Rittersgrün	7·1 to 7·8
		Iron disseminated in grains. 3. *Sporadosidères.*	*Polysidères* Quantity of iron considerable.	Sierra del Chaco	6·5 to 7·0
			Oligosidères Quantity of iron small.	Aumale	3·1 to 3·8
			Cryptosidères Iron not visible to the eye.	Chassigny Juvinas	3·5 3·0 to 3·2
II. *Asiderites.* Meteorites not containing iron in a metallic state		4. *Asidères.*		Orgueil	1·9 to 3·0

sidères, and *Cryptosidères*, according as the iron is—in great quantity (Sierra del Chaco); in small quantity (Saint-Mesmin, Aumale, etc.); or in indiscernible proportion (Juvinas, Chassigny). These sub-divisions are far from having the same value; but they each correspond to sensible variations in the density.

The fourth sub-division of coherent meteorites is that of *Asidères*, corresponding to the *Asiderites*, which is characterized by the absence of metallic iron. The number of specimens of this latter group is very limited, and nearly restricted to the carbonaceous meteorites (Alais, Orgueil). Such is the principle on which the classification is based; the differences and relations which are found in the two types of meteorites are shown in the preceding table.

NOTE.—The meteorite of Sierra del Chaco noticed above resembles, according to M. Gustav Rose, that of Hainholz, described by Reichenbach. Both are very different from other meteorites; they present the remarkable peculiarity of containing Augite, which is not accompanied by anorthite, as in the meteorite of Juvenas, but which is, on the contrary, associated with iron containing nickel, with peridot, and magnetic pyrites. Besides, the nickel, iron, and pyrites, on the one hand, and the peridot and augite on the other, occur in nearly equal proportions. For these meteorites M. Rose has proposed a special name, that of *mesosiderites*.[1] The arrangement of the meteorites in the museum of the Berlin University, by M. G. Rose, is based on their mineral character, and forms two divisions—the metallic and the stony meteorites, the first containing meteoric iron and the Pallasite, the second the Chondrites, Howardites, Chassignites, Chladnites, and lastly the Eukrites, which contain augite as well as anorthite. The meteorites of Alais and the Cape (and we may add that from Australia) contain carbon, and form with the mesosiderites two other groups.

We may here refer to the collection of meteorites in the British Museum, which, under the able direction of the present keeper, has been so greatly augmented that it now stands unrivalled both for extent and value of the specimens, the number being about 260. They are arranged in two cases; one contains the stony varieties or Aërolites, characterized by the presence of minute stony spherules. These are the Chondrites, Howardites, Chassignites, etc. They all contain meteoric iron in fine particles disseminated through them. In the other case are displayed the Siderolites and the Aëro-siderites. The former are masses of meteoric iron, containing stony matter; the latter consist of the metallic alloy of iron and nickel, with small amounts of other metals known as "meteoric iron." They also contain mechanical admixtures of compounds of these metals with phosphorus and with sulphur.—J. M.

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[1] *Vide* Sorby on the microscopical structure of meteorites. Proc. Roy. Soc., June, 1864.

REVIEWS.

SILURIA. By Sir RODERICK I. MURCHISON, Bart., K.C.B., etc., etc. [Third Edition.] Fourth Edition, including the "Silurian System." With a map, much new matter, and many illustrations. 8vo. 1867.

AS its title-page explains, this work consists of "A History of the Oldest Rocks in the British Isles and other countries; with sketches of the origin and distribution of native gold, the general succession of geological formations, and changes of the earth's surface,"—subjects which, we all know, have long ranked high as favourites among Sir Roderick's many scientific researches, and have had his earnest attention for many (some for nearly fifty) years. Again, then, has this veteran geologist, coming to the front with unabated energy and enlarged experience, applied his native acumen and clear judgment, his knowledge of details and power of generalization, to describe and elucidate the older rock-formations—the foundation-stones of half the globe, and to give the history of the successive systems of primæval life, as shown by the Palæozoic Rocks and Fossils of Great Britain and many other parts of the world.

Like all historians, Sir Roderick has had to apply to others for many data and for collateral information; and this he has received abundantly, and with justice fully acknowledged; indeed, he has taken pleasure in enumerating his helping friends and collaborateurs in his Preface (where upwards of twenty are mentioned), and his Index is rich with the names of authors and discoverers who have been quoted or referred to in furtherance of his work.

Furnished wilh the latest information from all sides, and enriched with the results of his own labours during the last ten years, he has carefully considered the rapidly accumulated facts and opinions relating to palæozoic geology, and has produced, as we might expect, a most valuable digest of all that is known of Laurentian, Cambrian, Silurian, Devonian, Carboniferous, and Permian Rocks and Fossils,—well written, well printed, and well illustrated; and supplemented, moreover, with chapters on the geology of gold and the philosophy of geology.

In the previous edition of "Siluria," Sir Roderick was enabled to lead the geologist to a still lower stage in the rock-structure of the British Islands than had been previously recognized, namely, to what he then termed the "Fundamental Gneiss," which comes out at Cape Wrath and the Lewis, and underlies the great Cambrian masses of Ross-shire (once thought to be "Old Red Conglomerate"), and the superposed Silurian quartzites and schists of Assynt, which, though disguised by metamorphism, were clearly recognised by the few fossils in their scanty seams of limestone. In the present edition Sir Roderick gives us a still larger, and at the same time more intimate, view of these oldest and lowest rock-masses, which, once muds, sands, and reefs, have long since been changed into crystalline gneiss and marble, and now constitute wide lands in North America and elsewhere. Sir W. E. Logan and his associates in the Geological

Survey of Canada have laboriously mapped and, as it were, unravelled (besides the many thousand feet of Lower Carboniferous, Devonian, and Silurian strata of that country)—a great lower series of quartzites, chloritic schists, clay-slates, marble, and bedded diorites, altogether 18,000 feet thick, and called by them "Huronian" (probably equivalent to our "Cambrian" rocks); and inferior still to this, they recognised the great "Laurentian System," Upper and Lower. The upper portion consists of the wide and crumpled sheets of hypersthene and dark felspathic rock so characteristic of Labrador, with gneiss and imbedded marble, altogether 10,000 feet thick; and this, as a really stratified though metamorphosed formation, "rests unconformably on the worn edges of a still older group of gneiss, quartzites, conglomerate, and marble, 20,000 feet thick at least, crumpled and crystalline, converted here and there into granite, and traversed by intrusive syenites and greenstones." These Lower Laurentian rocks are not only the disguised sands, clays, shingle, and calcareous sea-beds of the primæval earth, but bear witness to the life of the period; for their seams of Graphite represent coal or other carbonaceous layers of animal or of vegetable origin,—their apatite, fluor, iron-oxide, and pyrites "have reference probably to former animal organisms and their decompositions,"—worm-tubes occur in the schists,—and, besides obscure fragments like those of crinoids, corals, and shells, the structure of a real Foraminifer has been detected by Logan and Dawson in these old Laurentian limestones. Similar in relative position and in structure to that of Canada, the gneiss of Cape Wrath and the Lewis belongs to Sir William Logan's well-established "Laurentian System;" and, gracefully acknowledging his friend's hard-won discovery of this the earliest stage of the earth's terraqueous history, Sir Roderick thus dedicates this new edition of his work—"To the geologist who has not only applied my (Silurian) classification to the vast regions of British North America, but has taught us by his recent important researches that the Laurentian Rocks constitute the foundation-stones of all Palæozoic deposits in the crust of the globe, wherever their foundations are known."

The condition of these old schists and gneiss in Bavaria and Bohemia are carefully treated of, and indications of their existence in Norway, Spitzbergen, Finland, and elsewhere are given in "Siluria."

The nature, structure, and special features of the Cambrian rocks of the Longmynd, 26,000 feet thick, of Harlech and Llanberris, of Anglesea (where they are metamorphosed), of the North-Western Highlands, of Norway, Bohemia, and elsewhere, are next fully described and freely illustrated. These were once the *Bottom-rocks*, —these were once "Azoic;" but now the disentanglement of the so-called systems of mica-schist, slate, and gneiss, has opened out the above-mentioned 30,000 feet of still lower stratified formations (Laurentian); and the discovery of fucoids, worm-burrows, the Oldhamia, a Lingula, and a Trilobite, has partially, at least, educed the fauna and flora of these old Cambrian times.

The next overlying stage of deposits is represented by the succession of flagstones, grits, and fossiliferous schists, 5,000 feet (?) thick, long known as the "Lingula-flags;" but as their chief "Lingulæ" are *Lingulellæ*, and as *Lingulæ* abound also elsewhere, Murchison refers to them as "Primordial Silurian," after Barrande's name of "Primordial Zone." They flank both the Longmynd and the Malvern Hills on their western sides, comprising the "Holybush Sandstone" and Olenus-shale of the Malverns; they enter into the constitution both of Snowdon and of Cader Idris, on either side of the Harlech anticline; and they form the two great corresponding promontories of Caernarvon and Pembrokeshire. "This great series of Lingula-flags, so well developed in Wales, is the zone which, in Bohemia, through the enlightened researches of Mr. Barrande, has proved to be the basis of all Silurian life, and which therefore received from him the name of 'Primordial.' It is, indeed, clear that the fauna of this zone merits all the importance attached to it by its eminent founder, since we have now ascertained that, such as he has described it, the group exists in America, Scandinavia, Belgium, and Spain, as well as in the British Isles and Bohemia" (p. 47). This "Primordial Zone" is grouped by Sedgwick, Salter, and Lyell as the *upper* portion of the Cambrian system; but with Murchison's "Cambrian" these Lingulella-flags have nothing in common, except that one small *Lingula* (*L. ferruginea*, var. *ovalis*), and one Trilobite (*Palæopyge Ramsayi*) have been found in the latter, showing that the life of the Lower Palæozoic era had then already commenced.

The Llandeilo formation, very rich in Graptolites, Trilobites, and other fossils, and upwards of 5,000 feet thick (including its intercalated lavas and ash-beds of contemporaneous volcanic origin), next succeeds, forming a large part of Wales, and well represented abroad. The lower portion of this series has been divided off by other systematists as the "Tremadoc Slates," but Sir Roderick regards the latter as real passage-beds between the Primordial Zone and the Llandeilo flags, and inseparable in classification.

The Caradoc or Caradoc-Bala beds (4,000 feet in Shropshire, and thickened with upwards of 3,000 feet of contemporaneous volcanic rock in North Wales) are next described, with their many Brachiopods, Trilobites, etc. Lying on the Llandeilo flags (and, indeed, formed in the shallowing sea, which at first, when deeper, originated these latter shales and flagstones), the Caradoc beds cap Snowdon, and largely participate in forming the northern, central, and south-western districts of Wales and the border-counties included in Murchison's original "Siluria," or land of the old British *Silures* of Caractacus. This Silurian formation being shore-beds and sandy towards the east, its numerous shells have left only casts and moulds in the "Caradoc Sandstone;" but the more muddy beds of the western and northern parts of the area have preserved the calcareous matter of the shells and corals more perfectly in the "Bala Limestone." Such a difference of character, further modified by the intercalation of volcanic ash-beds, was originally a hindrance in the recognition of the geological identity of the several parts of this important group.

In the next set of deposits (the Llandovery), sandstones succeed schistose and slaty Caradoc beds in South Wales; and are there divisible into Lower and Upper (at Noeth Grüg); and the Upper Llandovery is again found in Radnorshire and the border counties, without the Lower member. Often full of the casts and moulds of fossils, as is the case also with the Caradoc Sandstone, the Llandovery beds have been mistaken for it,—especially the Upper Llandovery Sandstone of May Hill; but the fossils are mostly distinct in species, and *Pentameri* abound so much that they form a coarse calcareous band (Hollies Limestone) on the western side of the Worcestershire Beacon. The Llandovery beds are "Middle Silurian," but not distinctly separate from the Caradoc below and the Wenlock formation above,—their fossils being not very often "peculiar," some being found above, some below, and some both in upper and lower formations; but those of the upper part of the group more especially have alliances in the Upper Silurian formations which next come to be described. The "Tarannon Shales" are also mentioned as either occupying, in North Wales, the place of the Upper Llandovery Sandstone, or forming part of the next series (Wenlock formation), the local member of which, or the "Denbighshire Grits," there lies conformably upon them, passing upwards into ordinary Wenlock Shale. This last, with its two interbedded limestones,—the lower and thinner band being known as the "Woolhope Limestone," whilst the upper calcareous layers have the name of Wenlock or Dudley Limestone,—is the subject of an interesting chapter, which illustrates also the structure of the Wren's Nest and the curious Woolhope Valley of Elevation; just as in the course of the earlier chapters the physical features of Snowdon, the Breidden Hills, Caer Caradoc, the Malverns, the Stiper Stones, and the Longmynd are elucidated in connection with their geological structure.

The Ludlow formation, including the Aymestry Limestone as its middle member, comes next. The information obtained of late years respecting its uppermost portion, whereby it passes upwards into the Devonian Sandstones of Herefordshire, is reduced to order in chap. vii.; and the interesting discovery of the remains of a fish (*Pteraspis Ludensis*) in the Lower Ludlow beds at Leintwardine—the oldest vertebrate known—is alluded to.

The Silurian rocks of other parts of Britain, beyond the typical region of "Siluria," namely, in Cornwall, the North-west of England, Scotland, and Ireland, are studied in chapter viii. Here we see how greatly our knowledge of Ayrshire and Edinburghshire has been advanced by the Geological Surveyors and others; here also we have the history and relationships of the Lower Silurian schists, quartzites, and limestone of the Scottish Highlands clearly explained, as well as the Silurian series of Ireland, and its relation to the overlying Lower Devonian beds.

The next two chapters are devoted to an illustrated systematic account of the characters and distribution of the organic remains found in the Lower, Middle, and Upper Silurian formations; but there are also notices and woodcuts of Graptolites, Starfishes, Eurypterids, Corals, and many other fossils in the earlier chapters, where they come in as characteristic of the strata there treated of—there are others scattered through the after-portion of the work—and the Appendix contains not only supplemental palæontological notes, but a good synopsis of the Graptolites (by Mr. Carruthers), and an elaborate Table of British Silurian fossils, as now known, classified zoologically, and referred to their respective formations. This Table was greatly improved and augmented in the Second Edition by Mr. Salter; and now, in the Third, it has received nearly 300 additional species. At the same time, we may notice that several published species are omitted, because a careful examination has shown their identity with others previously described; and the student will observe also "that many of the long-known names of Silurian fossils have been exchanged for more correct names, according to the recent determinations of their real alliances, often obscure before, and only established on the discovery of more perfect specimens, and by an extended knowledge of extinct forms of life." This revised Table has been prepared by Mr. Etheridge, assisted by Professors Morris and Jones, who have had the help of Davidson, H. Woodward, Carruthers, and Duncan, in their special subjects of Brachiopods, Crustacea, Graptolites, and Corals; and they have had also the benefit of Mr. Salter's latest researches in Silurian Trilobites, Mollusca, etc., as well as the manifold labours of Barrande, James Hall, Billings, M'Coy, Baily, Edgell, Holl, and others, both at home and abroad. Not only in the Table, but in the body of the work, and in the Explanations of the Plates, the improved nomenclature has been adopted (a few exceptions are indicated in the list of *Errata*), many old names having been "exchanged for others more correct as to generic and specific affinities, or entitled to use by priority."

The life-history of the Silurian age has thus been greatly elucidated, not only by the better zoological and geological classification of the known fossils, but by the many new forms (especially of *Paradoxides*, *Conocoryphe*, and other Trilobites) obtained from the Lingulella-flags ("Primordial Zone"), and from the Tremadoc Slates, by Messrs. Salter, Hicks, Homfray, and Ash (p. 202, etc.), indicating the succession of a deep sea, alive with Invertebrates, to the almost barren shoal waters that deposited the "Cambrian" muds and sands, with no trace of former life in them in Canada and Scotland, with a minute *Lingulella* at David's, and with little enough where the Longmynd has raised up the old schistose, rippled, suncracked, and burrowed mud-banks, as part of the "Silurian" land.

For both the earlier and the later formations of the Silurian system, their life-history is also made clearer by the increased number of Trilobites worked out by Salter, Eurypterids by H. Woodward, small Entomostraca by Jones and Holl, Brachiopods by Davidson, Graptolites by Carruthers and Nicholson, etc. There will be differences of opinion as to the exact allocation of some of the new names, and of some of the accepted zoological views, in this Edition; but evidently great care has been taken in the laborious task of collating books, figures, and fossils; and Sir Roderick, as in former Editions, has been careful to secure the same painstaking and conscientious work in the palæontology as he himself has bestowed in the history and physical geology of these the oldest rocks of the British Isles.

We have space for but few remarks on points which are of interest to palæontologists. The Table opens with "Plantæ," but we expect that the *Spongaria* given under that head will prove to be casts of isolated septa of *Orthoceras*. *Actinophyllum* is like a radiating burrow-mark; and occurs also in the Lower Greensand of the Isle of Wight (Mr. Beckles' Collection). There is some confusion in applying the term *Salterella* to the tube-like fossils at p. 166, if the latter be due either to Annelids or Crustacea (as seems to be indicated); for Mr. Billings gave the name to a Pteropod. As for "Annelids," "Annelid-markings," and "Fucoids," we are glad to see an inclination to refer some of them to the trails and burrows of Crustacea (p. 166 and p. 201); and in this respect a reference to Dr. Dawson's *Rusophycus* (allied to some forms of *Bilobites*), and his opinion as to its being the mark of a burrow-chamber of a Trilobite would have been interesting to Silurian students.

The old fossil fish (the earliest Vertebrate) discovered by Mr. Lee at Leintwardine, in the Lower Ludlow formation, is alluded to at pages 126, 133, and 477, as a *Pteraspis*; it was referred to in 1864 by Mr. E. R. Lankester (Brit. Assoc. Report) as *Scaphaspis Ludensis*, whilst *Pteraspis truncatus* (figured at p. 240) is also a *Scaphaspis*, and *Pt. Banksii* is a *Cyathaspis* according to the same authority. Inadvertently this oldest species of Fish, and the reference to Mr. Salter's original description of it as *Pteraspis Ludensis*, in the "Annals Nat. Hist." of July, 1859, have been omitted in the Table at p. 536—an important but evidently accidental omission.

Recurring to the body of the work, with chapter xi. we enter on the Devonian rocks and Old Red Sandstone. Mr. Geikie's clear explanation of the structure of the Lower and Upper Old Red between the Cheviots and the Grampians is the first new point of interest in this chapter; a succinct re-written account of the Old Red Sandstone of North-eastern Scotland follows; and the good palæontological reasons for excluding the *Telerpeton*, *Stagonolepis*, and *Hyperodapedon* of Elgin from the Old Red category are fairly stated. Of so great importance is this matter to geologists in general that we here reprint the supplemental Notice (dated Oct. 30th, 1867) issued with the New Edition of "Siluria":—

"The reader of this edition will find that a very important change has been made in my views as given in former editions, respecting the age of the Upper Sandstones of Elgin and Ross-shire, which I have hitherto classed with the Devonian or Old Red Sandstone. My previous conclusion was founded entirely on the strong natural evidence presented to me by the conformable superposition of those *beds to the strata* of the inferior and unequivocal Old Red Sandstone replete with its well-known fossils. This opinion was confirmed by the examination of the rocks in question by Professor Ramsay, Professor Harkness, the Rev. George Gordon, the Rev. J. M. Joass, and others.

"The existence, in strata of Devonian age, of reptiles of so high a class as the Telerpeton (see fig. 73 in my last edition, p. 289) and the Stagonolepis was not, indeed, admitted by me without great reluctance, inasmuch as, if eventually substantiated, it would have weakened the main argument that runs through all my writings, which shows a regular progression from lower to higher grades of animals, in ascending from the older to the younger formations. Most joyfully, therefore, did I welcome the remarkable identification by Professor Huxley of the Hyperodapedon of the New Red Sandstone of Warwickshire with the Hyperodapedon of Elgin; and bowing, as I have always done, to clear palæontological proof, I have now excluded all that portion of my former editions which placed these reptiles in the Old Red Sandstone.

"The importance of this rectification, due to my eminent associate, has very recently received a wide extension; for among the fossil remains collected in India by the late Rev. S. Hislop, Professor Huxley has also found the Hyperodapedon.

"The formation in India containing this reptile has been considered by Professor Oldham, the Director of the Indian Geological Survey, to be either the Trias (New Red Sandstone) or the representative of an intermede between the Palæozoic and Mesozoic rocks. In all probability this correlation will have to be extended to South Africa, since one of the characteristic fossil reptiles of that country, the Dicynodon, has been found in the Ranigunj beds of this age in India."

The Devonian rocks of Cornwall, Devon, and Ireland have evidently received the most careful attention in this revised chapter xi., Mr. Jukes's new views of the relations of these rocks having required special consideration. With a clear knowledge of all former researches, and supported by Messrs. Salter and Etheridge's late examinations of the strata and fossils, Sir Roderick groups the upper portion of the Barnstaple band only with the Lower Carboniferous Limestone-shale, the Devonian formations ending with the Pilton and Marwood series, the latter of which may be the equivalent of the "Coomhola Grits" of the South of Ireland. In Dingle, South-eastern Ireland, the Lower Devonian schists, slates, grits, and sandstones lie comformably on the Upper Silurian; and on these "Glengariff Grits" (the Middle Devonian being absent) the Upper Old Red rests unconformably, and passes upwards into the Carboniferous series,—a condition of things analogous to what is seen in the Pentland Hills.

Chapter xii. treats briefly but comprehensively of the Coal-fields of Great Britain and Ireland. Mr. Geikie has supplied a succinct account of the Carboniferous series in Scotland, as worked out by the Geological Survey. Of the Lower Carboniferous Rocks of Ireland, it is remarked that it is their "strong lithological resemblance view the best of the old-fashioned thoughts and ripe opinions, whilst Ice-action is everything to some,—whilst Rain-action is the universal agent with these, and Sea-waves with those,—whilst Negative Evidence is the bug-bear of one party, Homotaxis a puzzle for another,—the gradual out-coming of new forms the belief of some, and the uniformity of nature, both physical and vital, the dogma of others.

Once more, then, geologists have to welcome a revised edition of one of the most valuable of geological works, which, only by the use of much small type, has been made to contain within reasonable compass the great number of important additions to his Science that the author has had to notice. The many counties in England, Wales, Scotland, and Ireland that have their structure elucidated and their mineral wealth more or less treated of in this book, must all supply many students and thankful readers. The traveller finds it of use, not only in Europe and North America, but in other parts of the world; indeed, an educated man anywhere can find something of interest in its less technical pages. The geologist proper well knows its value; for, though he may here and there find more of the personal history of Silurian research than he cares for, yet never, perhaps, will another such work be produced, in illustration of the subject-matter it treats of, characterized by so full and perfect an association of the results arrived at by co-operating geologists, of all nations, clustered round a worthy centre—the author of this new edition of "Siluria,"—a work rich in good facts, well arranged, and written by an earnest, mature, and philosophic mind.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—December 18th, 1867.—Warington W. Smyth, M.A., F.R.S., President, in the Chair. The following communications were read:—1. "On the Parallel Roads of Glen Roy." By Sir J. Lubbock, Bart., F.R.S., Pres. Ent. Soc.

The author did not enter into the question as to the manner in which the valleys were filled with water, but assuming that the "roads" or "shelves" represent ancient water margins, he attempted to point out the manner in which they were produced.

The theory of Macculloch, which has been adopted by Darwin, Lyell, and Jamieson, is, that the matter brought down by frost, rain, etc., from above, was arrested by the water, and heaped up by the action of the waves. If this was the true explanation, however, Sir John argued that the roads would form an excrescence on the slope of the hill, which they do not; that their breadth must vary considerably; that the slope of the roads would be towards the hill; and that the roads would be widest where the inclination of the hill is less than usual, and where streams bring down matter from above; whereas, on the contrary, in these places the roads disappear.

In opposition to this theory, Sir John then argued that the action of the waves, under such circumstances, would be to throw matter down, and not up. Given a slope of angular débris standing at the angle of repose, partly in air and partly in water, the angle will be about the same throughout, because the angle at which matter will stand depends partly on gravity and partly on friction. Now, as long as the water is at rest, the equilibrium in water remains as in air; but as soon as the water is agitated, the friction is diminished, and the angle of repose becomes less. In other words, the pebbles are set in motion, and roll down the hill.

This explains the equal width of the roads, because the new angle of repose being equal throughout, and the depth to which the agitation extends being also equal, the width of the road must be equal also; and when once the new slope of repose was acquired, the hill-side would again be in a condition of equilibrium, and the road would receive no further enlargement, however long the water might stand at the same level. This explains why there are no roads when the natural rock appears, or when the hill-side is less steep than usual; whereas, if the roads were due to a heaping-up action, of course in places where the sides were more shelving the roads would be better marked. We can also thus understand why there are no rolled pebbles on the roads; and lastly, as the lower line of the roads marks the depth to which the water was disturbed, we can see why the roads become narrower wherever they are steeper than usual.

Finally, the vertical height of the roads—that is to say, the vertical difference between their upper and lower lines—gives the measure of the depth to which the water filling the valleys was agitated, and affords thus an additional argument in favour of its having been that of a lake, as in a tidal sea the width of the roads must have been much greater than it is.

2. "Remarks on the Geological Features of the Northern part of Formosa and the adjacent Islands." By Cuthbert Collingwood, M.B., F.L.S. Communicated by the Assistant-Secretary.

The west coast of Formosa is flat, consisting of low alluvial plains, with a few hills, some of which approach the coast; a range of mountains runs nearly through the island. Near Tamsuy, on the right bank of the river, is a thick deposit of clay, containing boulders on which the author could detect no traces of glacial striæ. Higher up the river, on the north side, hills containing sulphur-springs rise from the plain. On the north-east side of the island sandstone extends from Masou peninsula, north of Kelung, to Petou Point on the south-east. The harbour of Kelung is a spacious excavation in the sandstone, which is hollowed out into numerous caves; and Dr. Collingwood states that the land is slowly rising, blocks of water-worn coral being found above high-water mark. Sano Bay, the only harbour on the east coast, is protected by a reef composed of trap-rock. The Pescadores are of volcanic origin, and are composed of basalt. The author then describes Hai-tan, and the islands of Craig and Agincourt, which lie to the north of Formosa, as well as the Pinnacle Islands, lying still further north.

3. "On some Sources of Coal in the Eastern Hemisphere." By Cuthbert Collingwood, M.B., F.L.S.

1. *Kelung, Formosa.*—The coal is found in depressions in Red Sand-

the lowest rocks of the Silurian; in the strata of the Old Red Sandstone the schists are marked with the little microscopic spots where they have been. In many limestones they are well preserved; in the Coal-series they are so abundant that they make up massive layers, and so through all the groups, as plentifully in the marine as in the fresh-water beds. Existing as they did in such vast numbers in the waters and muds of the ancient seas and rivers, it necessarily follows that the accumulated shells of the dead specimens should far outnumber the living; and when we examine our ponds, etc., at the present day, and find them teeming with this form of animal life, we may understand how largely these minute crustacea have contributed to form the carbonate of lime in the various rocks above mentioned. The speaker explained how new forms had been discovered in the mud of foreign countries, and requested his hearers to induce any of their friends who might be going abroad to bring or send home pill-boxes filled with the dried mud of any of the rivers or lakes they might pass in their travels. By keeping these carefully separated, and putting them in distilled water on their arrival in this country, he said that many new and interesting species might be developed. *Land and Water*, January 18, 1868.

CORRESPONDENCE.

DR. T. STERRY HUNT'S GEOLOGICAL CHEMISTRY.

SIR,—In the last number of the "Chemical News"[1] (Jan. 17), Dr Sterry Hunt has inserted a reply to some remarks of mine contained in No. 409 of that Journal, but which, in reality, is in great part a criticism on the contents of my communication to the GEOLOGICAL MAGAZINE for October last, the substance of which Dr. Hunt accuses me of having, "for some unknown reason, witheld from the readers of the 'Chemical News.'" The absurdity of this accusation is self-evident, as in the "Chemical News" the reader is distinctly given to understand that the communication was but a supplement to the previous one in the GEOLOGICAL MAGAZINE of October 1st; and, as you are aware, in the GEOLOGICAL MAGAZINE of that date, special attention is directed to this forthcoming supplement. I would, therefore, ask the favour of your inserting in your forthcoming number the enclosed communication, which, by also appearing in the next number of the "Chemical News," will, I hope, satisfy Dr. Hunt that it is not my wish to withold any of the points of this controversy either from the readers of the "Chemical News" or of the GEOLOGICAL MAGAZINE.

20th December, 1868. DAVID FORBES.

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[1] If the reader will compare the article by Dr. T. Sterry Hunt, in the *Chemical News*, here referred to, with that contained in our present Number, p. 49, he will perceive, that, to a great extent, they are the same; this letter is therefore capable of being treated as a reply, *in part*, to both of Dr. Sterry Hunt's communications; but there are several points discussed by Dr. Hunt in this MAGAZINE which are not entered upon in the *Chemical News*. To these Mr. Forbes will no doubt reply after he has seen and compared the two articles.—ED.

ON SOME POINTS IN CHEMICAL GEOLOGY.

By David Forbes, F.R.S., etc.

In the "Chemical News" of October 4th, 1867, I commenced some remarks under this title, for the express purpose of exciting more interest in the application of Chemistry to Geology, and with the hope of starting a discussion which might at the same time enliven as well as elucidate the subject. Accepting Dr. Hunt's invitation,—his views, being the most recent, were first selected for consideration, and although that gentleman now appears greatly astounded at my presuming to differ from his opinions, it is still highly gratifying to find that he has at last condescended to reply.

As this reply, however, contains absolutely nothing which can in any way affect or modify the opinions which I have already expressed on the views of Dr. Hunt, or even require a reconsideration of the arguments upon which those opinions were based, I am enabled to reply *tout de suite*.

Dr. Hunt adopts a line of argument which is an elaborate attempt to convince his readers of the utter incompetency and ignorance of his reviewer; yet, at the same time, it is amusing to observe that the character and tone of his remarks, in conjunction with his studious avoidance of some of the knotty points and more important arguments brought forward in opposition to his views, are strikingly suggestive of his being afflicted with a presentiment that there may after all be rickety points in his theoretical views.

Men who live in glass houses should not throw stones; Dr. Hunt's accusations of ignorance will appear strange to those who have paid attention to some of his sweeping assertions: amongst others, for example, when he emphatically declares that quartz "can only be generated by aqueous agencies," geologists will infer that Dr. Hunt must be ignorant of the most important fact, that quartz is found in abundance in volcanic lavas in many parts of the world, although not in Canada.

Had Dr. Hunt remained content with his Canadian laurels, he would probably have enjoyed them in peace without having his opinions disputed; but when he now aspires to be recognised in Europe, he cannot complain if his views be criticised by any or all of those interested in the subject—an ordeal which must be undergone before he can expect them to receive general acceptance, for surely he does not issue them as axioms or oracles. Europe differs greatly from Canada, and amongst other things, in close competition being the order of the day. No man in Europe can expect to retain any portion of the field of science exclusively for himself, or to travel alone on any of the many different roads which lead to one and the same scientific truth.

If real progress is to be made in science, the student must reason for himself, and not be content with accepting, merely on authority, opinions which are inconsistent with his own deductions or experiments; nor should he be deterred by the opposition to be expected from those already in office or authority, who are sure to be jealous of intruders on what they imagine to be their own domain, and, doubtless, dislike having their peace of mind disturbed by innovations.

A discussion of this nature may be carried on in two ways, either by considering the main points of the argument first, before engaging in the minor details, or the reverse; Dr. Hunt prefers the latter course, which, no doubt, is best suited to the defence of a weak cause, but which his rather rambling remarks in last week's *Chemical News*[1] will show is not calculated to convey to his reader any very clear idea of the exact points at issue, and is likely to confuse by then umber of minor details, having little or no bearing upon the main questions.

It is, therefore, most important for me that no misunderstanding should arise as to the exact points on which I have presumed to differ from the principles of chemical geology which Dr. Hunt has recently brought before the scientific public in Europe.

Expressed in as few words as possible, I object to the following of Dr. Hunt's assumptions or assertions:—

1. That the earth is solid to the core.
2. That the surface of the earth, immediately previous to its entire solidification, was "a liquid bath of no great depth surrounding the solid nucleus."
3. That the original atmosphere contained "the whole of the chlorine in the form of hydrochloric acid, the sulphur as sulphurous acid."
4. That the saltness of the sea is due to a rain of hydrochloric acid "flooding the half-cooled crust" with a highly heated acid deluge.
5. That the whole of "the calcareous strata, the marbles, and various limestones which we find on the earth's surface" have been precipitated from the sea by carbonate of soda.
6. That all the magnesian limestones and gypseous beds were formed in a dense atmosphere of carbonic acid.
7. That quartz "can only be generated by aqueous agencies."
8. "That granite is in every case a rock of sedimentary origin."
9. That volcanic rocks are merely ordinary sedimentary beds, melted by being "depressed, so that they come within the action of the earth's central heat."

Any minor differences fall naturally under these heads, and I may add that the perusal of Dr. Hunt's defence has confirmed me more than ever in the belief that the above premises are unsound, and I shall now endeavour, as concisely as possible, to examine the arguments *pro et contra.*

I.—The earth solid to the core.

Dr. Hunt seems to imagine that if the earth is not solid to the core, it can only consist of an immense central sphere of molten matter covered by a thin external crust or shell, for he wastes all his arguments in attempting to upset this theory, to which I had never given my adhesion.

I have preferred adopting in the main the hypothesis of Bunsen, no mean authority, and when opposing Dr. Hunt's views simply asserted my opinion that the earth still encloses "a vast reservoir or reservoirs of still fluid igneous matter in its interior;" and the main argument with which I support this opinion is, that I consider that the molten lava ejected from volcanos must be derived from some such source. This is a very simple but common-sense view of the case, which I imagine Dr. Hunt will find some difficulty in refuting.

II.—That the earth's surface immediately previous to its entire solidification was "a liquid bath of no great depth surrounding the solid nucleus."

Hopkins has taken into favourable consideration the supposition that the earth actually was solid both in its centre and crust, and yet might retain fluid igneous matter in the intermediate space; and taking a somewhat similar view of the case, I believe that, even allowing that the solidification actually did commence at the centre, it still could not have reached the exterior before, on the other hand, the surface itself had also solidified and formed a crust commencing from the exterior, due to the external cooling action.

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[1] It is necessary to explain here that many of Dr. Hunt's observations refer to a previous communication in the October Number of the GEOLOGICAL MAGAZINE, and not to the subsequent one in the *Chemical News* of Oct. 4, which, as is distinctly stated therein, is only supplementary to the former and to be read in conjunction with the same; yet Dr. Hunt indulges in the absurd accusation, that the contents of that communication have, "for some unknown reason, been withheld from the readers of the *Chemical News.*"

In opposition to this, Dr. Hunt states that silicates, when cold, are from one-seventh to one-sixteenth part more dense than when molten, and would at once sink down into the fluid mass below, and further adds that no crust could be formed unless the laws of gravity were suspended. I do not know what Dr. Hunt's idea of the laws of gravity may be, but I would merely again ask how far he imagines a crust of sp. gr. 2·6 could sink down into a molten sphere of a mean sp. gr. 5·3. I will not, however, repeat the other arguments which I have used in the GEOLOGICAL MAGAZINE, but content myself by bringing forward one not before employed by me in support of my opinion.

Some experiments which I am now engaged in, on the effect of heat on bodies which contract in cooling, *i.e.* which are more dense when cold than when molten, show in the cases tried that a body upon the first application of heat expands and continues to do so up to near its melting point, when it contracts at the instant of fusion; in other words, although the substance when cold was heavier than when molten, yet the same substance expanded by heat was lighter than when molten. Thus, some metals were found to float about (like ice upon water) upon the surface of a molten bath of the same metal into which they were placed in a heated condition.[1] It appears probable that the same phenomena would account for such a crust as Dr. Hunt disputes, not sinking but floating on the molten bath below.

That the earth may possibly have solidified at the centre first, is not disputed by me, nor does its so doing in any way affect my theoretical views. The object of my observations on this head was to show that we are altogether too ignorant of the character of the central mass of the earth, and of the effects likely to be produced by such enormous pressures, to be enabled to reason upon such insufficient data with any confidence in the result.

III.—That the original atmosphere contained "the whole of the chlorine in the form of hydrochloric acid, the sulphur as sulphurous acid."

The perusal of Dr. Hunt's remarks does not in any way tend to modify the conclusions I had previously arrived at on this head. I still believe that chemists will not be disposed to regard an atmosphere containing enormous volumes of sulphurous acid, steam, and oxygen in excess, or in other words, which resembles a great sulphuric acid chamber, as *probable*; and as Dr. Hunt does admit that they would slowly unite to form sulphuric acid, it merely becomes a question of time as to whether they united slowly or quickly.

The arguments which I advance against supposing that such an atmosphere ever did exist are, that I consider that the sulphur would unite mainly with the heavier metals, and the chlorine mainly with the alkaline metals, and I consequently infer that these elements never went into the atmosphere in any such quantity as Dr. Hunt imagines.

Dr. Hunt, in opposition, states that sulphides could not be formed, since oxygen was in excess. Metallurgists know that sulphides are far less easily oxidizable than is generally imagined, and that they are produced in both blast and air-furnaces when the waste gases still contain unconsumed oxygen, and that time is an important element in this consideration.

But we have no proof whatever of any great excess of oxygen in the primeval atmosphere; on the contrary, we know that a vast amount of the oxygen now present in the air must have been derived from the decomposition of the carbonic acid, when the immense supplies of carbon afterwards buried in the various sedimentary formations were extracted from the atmosphere by the action of vegetable life. The slight excess of oxygen which, no doubt, was present would, further, be so diffused through the enormous volume of carbonic acid, nitrogen, and aqueous vapour, that it cannot be imagined to have exercised other than a most feeble oxidising action.

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[1] As a metallurgist I have frequently observed such cases, but for a long time did not understand the explanation; I have to thank my friend Mr. Hackney for directing my attention to the behaviour of Bessemer steel under these circumstances, as it gives great trouble to the workmen by persistently floating high on the surface of the melted steel (even when in pieces of 40 lbs. or more) as long as its temperature is below its fusing point.

The carbonic acid, also, being so infinitely more dense, and present in so overwhelming a quantity, would further act as a powerful shield against the very oxidising action which Dr. Hunt lays such stress upon.

That the chlorine did not go into the atmosphere, as Dr. Hunt imagines (combined with hydrogen as hydrochloric acid), I infer from the well-known far greater affinity which it has for sodium than for hydrogen, and the volatility of the sodium would be far more likely to bring it in contact with the chlorine than with the silica.

The idea that the action of the feeble excess of oxygen above alluded to, in connection with silica and steam, would prevent the formation of chloride of sodium, is not of much weight, since the chloride of sodium would be formed as a vapour in the atmosphere, while the silica remained below in the earthy mass in a solid form.

But Dr. Hunt next writes: "Even if, as Mr. Forbes supposes, the chloride of sodium were to be formed in the heated atmosphere, it would be precipitated into the intensely heated bath," etc. *Precipitated!* when it would be in the state of vapour at this temperature.

Metallurgists know how indifferent chloride of sodium is when fused with silicates, and to this property is due the employment of what is termed a salt-cover in assays; however well the salt may be intermixed, once the mass is fused it rises and swims on the top, and (if the heat be not too elevated or protracted as to volatilise it entirely) presents, upon cooling, a well-defined crystalline crust of salt, below which is found the unaltered silicate slag, and below this again the button of metal, pure or more or less in combination with sulphur, arsenic, antimony, etc., as the case may be; thus presenting, on the small scale, an illustration of what I have supposed may have occurred in nature, in which case also the cover or crust of salt would act as a shield against oxidation.

In a potter's kiln, the vapour of salt *under confinement* merely glazes the surface of the ware to a minute depth, which very glaze protects the silicates from further action; but both the potter's kiln and Gossage's soda-process are worked under forced circumstances, not applicable in this argument; and when Dr. Hunt explains that in his illustration of this subject he merely used the words, "*if the elements were made to react upon one another*," is it not rather he who is trifling with the subject, when he supposes conditions which never could occur in nature in the case referred to.

IV.—That the saltness of the sea is due to a rain of hydrochloric acid "flooding the half cooled crust" with a highly heated acid deluge.

This assumption requires no further comments than those included under the preceding head, where I have endeavoured to show that the whole of the chlorine did not ascend into the atmosphere as hydrochloric acid, and, consequently, could not flood the earth with the hot acid deluge insisted on by Dr. Hunt.

V.—That the whole of "the calcareous strata, the marbles and various limestones which we find on the earth's surface," have been precipitated from the sea by carbonate of soda.

Geologists have long agreed, that sedimentary limestones are the products of the action of organic life; and microscopists, in confirming this, have further proved that they do not possess the character of precipitates. Dr. Hunt evades any reply to these objections, but asks a question in return, requesting to know what becomes of the acid in case, as I contend, animals can utilize the salts of lime contained in the sea. As is well known, sulphur plays a very importan part in vital economy, entering both into the composition of organisms, and being also given off as sulphuretted hydrogen in the gaseous form. I see, therefore, many reasons for believing that animals do assimilate the sulphate of lime, which we know is contained in such an enormous quantity in the ocean.

VI.—That all the magnesian limestones and gypseous strata were formed in a dense atmosphere of carbonic acid.

In 1846, when in Birmingham, I was informed that for some years the manufacture of magnesian preparations was based upon the reactions of the compounds of magnesia with carbonic acid, in a compressed atmosphere of carbonic acid. In 1849, Mr. Osborne, a gentleman connected with a similar manufactory in Ireland, fully confirmed these statements, and shortly after the publication of Dr. Hunt's paper in the Comptes Rendus, Dr. Lawson, in the course of conversation, expressed his surprise at Dr. Hunt being unaware of this, since he knew that the principle had been long in use in a manufactory at Cork.

Dr. Hunt has further applied this principle,[1] and obtained very interesting results, which he considered to be the counterparts of nature's operations; and, remembering that there are dolomite beds in the lower Silurian strata of Canada, at once asks geologists to believe the rather hasty generalization that all the magnesian limestones and gypseous beds were formed in a dense atmosphere of carbonic acid.

Geologists, however, well knowing that the grand development of magnesian limestones and gypseous strata occurred in periods when air-breathing animals existed on the surface of the globe, could not believe that these animals actually lived in a dense atmosphere of carbonic acid; and had some of the more modern great gypseous formations occurred in Canada, Dr. Hunt would probably not have brought forward this theory.

VII. That quartz "can only be generated by aqueous agencies."

Dr. Hunt, wisely no doubt, does not take any notice of my arguments against this assertion, since they are facts, not opinions, and consist merely in pointing out that volcanic lavas of Italy, Hungary, Peru, Bolivia, Chili, etc., contain abundance of quartz often in well-defined crystals. In connection with this I may here extract a passage from a letter received from Mr. Sorby, who writes, "I have splendid cases of recent lavas with quartz, both in the shape of small crystals and as rounded masses, like those seen in some older rocks; and this quartz in both cases (crystals and rounded masses) contains splendid glass cavities, just like those in the felspars, the Arran pitchstone, and the various lavas; thus we have complete proof, according to my views, that quartz both can and has crystallized out from a melted mass of rock." Now, in face of such facts, what importance, may I ask, can be attached to such of Dr. Hunt's dogmatic assertions as, "that the composition of the primitive crust would have excluded free silica?" that quartz "is only the result of a secondary process?" etc.

VIII.—"That granite is in every case a rock of sedimentary origin."

Dr. Hunt makes this assertion in opposition to the opinion of many able men who have well studied the subject. If he, however, only founds this opinion on the presence of quartz in granite, the value to be attached to it may be inferred from the remarks contained in the preceding paragraph. If he speaks as a geologist, it may fairly be inquired whether he considers his Canadian experience sufficient to enable him to arrive at such sweeping generalization.

Sir Charles Lyell has stated that three things were essential to a geologist, namely, "to travel, to travel, and to travel;" and such advice may be recommended to Dr. Sterry Hunt before he ventures again to generalize for the world on the strength of a local knowledge of a very minute part of the same.

IX.—That volcanic rocks are merely ordinary sedimentary beds, melted by being "depressed, so that they come within the action of the earth's central heat."

In the GEOLOGICAL MAGAZINE I ventured to inquire of "the author of this ingenious theory by what mechanical arrangement he supposes strata, on the surface of the earth, to be lowered down into a globe solid to the core;" and again, "how are we, according to this theory, to account for the fact that volcanic rocks, taken from any quarter of the world, no matter how far distant from one another—from Iceland or Terra del Fuego, from the Islands of the West Indies or from those of Polynesia—that in all cases such rocks possess an absolute identity in chemical and mineralogical composition, in physical and optical properties: can any geologist be expected to believe that such rocks have been formed by the melting up of a mere mechanical aggregate of rock débris, possessing no analogy whatsoever, and whose chemical composition, etc., is known to vary to the widest imaginable extremes?"—questions as yet unanswered.

Before concluding these remarks, I would here acknowledge that Dr. Hunt has discovered an inaccuracy which occurs in my communication to the GEOLOGICAL MAGAZINE, where the position of steam in the imaginary original atmosphere is by accident placed below that of air, although steam is in reality lighter—as a moment's reflection would have shown. This error has not the most minute influence on any of my generalizations, as it is perfectly immaterial whether this stratum be above or below that of air.

I shall always be ready to admit at once any error which may be found in my communications, and Dr. Hunt is quite entitled to make the most of such a blunder, if he considers it will support his views; at the same time I trust that he will also be equally candid in cases where he may be found tripping.

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[1] Vide *Chemical News*, Sept. 13, 1867, p. 148.

Dr. Hunt alludes to a rough sketch of some of my views contained in the GEOLOGICAL MAGAZINE; but as I have already accepted the invitation of the Council of the Chemical Society to give a lecture on Chemical Geology (20th February next), Dr. Hunt will thus be enabled to take my views into full consideration, and after comparing them with his own I trust he will give us the benefit of his scrutiny; for as I regard the ultimate object of all my labours as being the attainment of scientific truth, I am as fully prepared to be corrected in points where I may be proved to be wrong as to defend those which I hold to be right.

THE BOULDER-CLAY AT WITHAM AND THE THAMES VALLEY.

SIR,—Mr. Dawkins has spoken of the occurrence of a Boulder-clay at Witham as affording a presumption that the valley there is older than the glacial drift. I am able to give a rough section of the boring for the well in which it occurred, where I saw it in 1865. I obtained the depths from the men at work, in answer to questions regarding the stuff which I saw to have been brought up.

SECTION OF ARTESIAN WELL AT WITHAM STATION, ESSEX.	Feet.
Coarse gravel	20
Greyish Glacial clay, with large flints and chalk pebbles	150
Fine clayey sand, brown and green, with green-coated flints at the bottom, (Thames sand)	10
Chalk, in which the water was obtained.	

The spot is more than 20 feet above the stream, so that the gravel is a terrace gravel; and, in what is probably the same bed, I found a short time previously a good specimen of an oval flint implement: I picked it off a heap in the gravel-pit, at the entrance of the lane which leads to the Goods' Depôt.

Now, as regards the glacial clay in this section, there is a peculiarity which at the time surprised me much. I allude to the entire absence of anything like the "middle drift" beneath it. This drift occurs in full force along the high ground to the south, by Danbury and Wickham Bishops; and Mr. S. V. Wood, jun., has shown it in section 9 of his paper on the Essex valleys,[1] as underlying the Boulder-clay at Little Braxted close by. A glance at that section will show that the position of the Boulder-clay at Little Braxted has no analogy with that at Witham Station, where it extends many feet below the bottom of the valley. These circumstances, to my mind, throw a considerable doubt upon the clay at the station being the true Boulder-drift; and if it be not, we cannot argue from it that the valley is older than the Boulder-drift.

We are told of the existence of several Boulder-clays—and I can myself speak to a Boulder-clay occupying a valley in Essex which is clearly newer than the true Boulder-drift. It is to be seen on the shore, beneath the terrace, at Walton-on-the-Naze. It contains Chalk pebbles, large flints, London clay septaria, and Crag sand, and is full of mammalian bones. In hard specimens it could not be distinguished from the older Boulder-clay.

I have not a sufficiently minute acquaintance with the neighbourhood to be able to contribute many observations to the elucidation of the question at issue regarding the age of the Thames valley. But, as I have already stated in your pages, I cannot admit the presence of the re-arranged material, which I call "trail," to be any proof of geological antiquity; regarding it, as I do, as an accompaniment of the last general denudation of the surface. When Mr. Wood says that he does not admit the existence of this deposit (though it is not strictly a deposit) as "a formation,"[1] I understand him to mean that he thinks that peculiar condition of the sub-soil to be of various geological ages, from the glacial drift upwards, instead of referring it to our period, as I do. Thus, although we disagree upon the age of the trail, we are in accord as to its existence, and also as to its having no bearing on the question in hand, viz., the antiquity of the mammaliferous deposits of the Thames valley.

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[1] GEOL. MAG., Vol. III. p. 348, map.

It was asked during the discussion on Mr. Dawkins' paper, why the Boulder-clay did not cross the valley of the Thames. I then offered the suggestion that the cause might be found in the elevation of the Weald. *Denudation is a function of altitude.* In a given district it requires a certain amount of coherence in the constitution of a deposit to enable it to resist destructive influences of altitude. Hence, if the Boulder-clay was once spread over the North Downs—and they have been raised higher since—we need seek no other reason for its disappearance in that area. There is, I believe, a parallel case in Hants and Dorset. The elevation of the southern part of the Isles of Wight and Purbeck, and of the Weymouth district, south of the uplifted chalk, is probably of the same date as that of the Weald. Now, in the south-western counties, the Boulder-clay, as I believe, is represented by the thick bed of coarse flint gravel which forms the capping of most of the tabular hills of the New Forest and of the Tertiary country of South-east Dorset. But this bed of gravel does not cross the Chalk Downs. It appears to have been lifted up and carried away together with all the other deposits which once lay upon the Chalk; and, in passing, I may mention that the Tertiary strata which cap Ridgway Hill near Weymouth are vertical, being just as much affected by the disturbance as those of Alum Bay.

Now the Thames valley is so near the northern boundary of the Weald that we may well conceive the local disturbance to have been felt in it. And, indeed, the occurrence of a fault bringing up the Chalk against the London clay near Purfleet is probably part of the same movement. Again, the altitude attained by the Middle Drift along the hills south of Chelmsford and Witham is almost in itself sufficient proof that the disappearance of the Boulder-clay in that direction is due to denudation.

My impression is, that the mammaliferous bed of Grays Thurrock is of the same age as that of Clacton. It is possible that species may be present in the Clacton deposit which have not been collected, for it is most difficult to obtain specimens there. The late Mr. John Brown, by a combination of assiduity and good fortune, obtained a good many; but although I watched the place for nine years I never got a single bone, and am persuaded that the bed during that time was not once laid open by the tides. On the other hand, the excavations in the Thames valley are very extensive, and continually worked, so that, probably, most of the species have turned up which are there buried. There is certain proof of the depression of the Clacton area subsequently to the period when the mammalia were entombed, for the bed in which they lie is purely freshwater, and it is covered with several feet of brackish water beds, with small *Scrobiculariæ*; and at the top of the section occurs a seam in which I found *Cyrena fluminalis*, associated with dwarfed *Cardium edule*, and a *Paludina* undistinguishable from *lenta*. Now a similar depression of the area seems to be shown at Grays, by the false bedded sand, No. 5 of Mr. Dawkins' section,[1] overlying the mammaliferous gravel.

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[1] Geol. Mag., Vol. V. p. 43.

The Clacton deposit is a true valley deposit, cut out of the London clay, and an overlying gravel which Mr. Wood calls the "East Essex Gravel." This gravel, as I understand him, he supposes much newer than the Boulder-clay; but at any rate it cannot be older than the Middle Drift, and in either case it throws the Clacton deposit into Post-glacial times.

O. Fisher.

Harlton, Cambridge.

BOS LONGIFRONS.

Sir,—Owing to my absence from England, I have only just enjoyed the pleasure of reading the memoir which my friend Mr. Boyd Dawkins has contributed to the "Quarterly Journal of the Geological Society," and which appears in their 91st No., p. 176. There are some passages in this to which I may reasonably be allowed to demur, and I therefore, while giving Mr. Boyd Dawkins the utmost credit for the ability with which the case for the plaintiff has been stated, will at once proceed to open the defence.

The characters of *Bos longifrons* are clearly described by Mr. Dawkins, with such lucidity, in fact, that he is "unable to assign any characters of specific value to the animal." But I cannot allow that he shows sufficient cause why two out of the three other species of fossil English Bovines should be abandoned. In a memoir of eight pages, exactly twenty-one lines are devoted to the examination of the claims of *Bos frontosus* to specific distinction; whilst *Bos trochoceros* is utterly ignored. Both these species were found associated with *Bos longifrons* in a refuse heap in London Wall, by my friend Lieut.-Colonel A. Lane Fox, F.S.A., and the circumstances of their *gisement* have been accurately described by him in the "Journal Anthrop Soc. Lond.," Dec. 1866. Of their identification there can be no doubt, and the specimens will be gladly placed in Mr. Dawkins' hands for description.

Mr. Dawkins' argument is as follows,—"A very large number of skulls from the Irish turbaries in the Museum of the Royal Dublin Society show a marked gradation in size and form, and constitute an unbroken series with the *Bos frontosus* of Nilsson at one end, and the more common variety of *Bos longifrons* at the other. * * * In consequence of this, I am unable to assign any characters of specific value to the animal. * * The *Bos frontosus* of Nilsson is proved by the series in Dublin, as stated above, to be a mere variety." Such, and such only, are the grounds on which Mr. Dawkins disposes of this species. He gives two measurements of skulls of individuals who confessedly appertain to *Bos longifrons*, and have no "Frontosine" characters, and eight measurements of horn-cores.. No further are vouchsafed to us; none are even promised, though we learn that some detailed measurements of teeth and long bones are to be appended at the end of his third paper. The facts are not forthcoming, or at least are not shown, on which *Bos frontosus* can be eradicated from the catalogue. It is quite possible that the large series of *longifrons* remains in the Dublin and Oxford Museums may corroborate Mr. Dawkins' conclusion; those in the British Museum and Royal College of Surgeons Collections, to which Mr. Dawkins appeals, have not led me, after most careful examination, to arrive at the same result. Science imperatively requires, not a mere sweeping assertion that *Bos frontosus* "cannot be made out" as a species, but a careful series of measurements of at least fifty specimens, so that the "unbroken series" which Mr. Dawkins imagines to exist may be distinctly shown. Till evidence is really put in, Nilsson's species must be allowed to stand.

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[1] Quart. Journ. Geol. Soc. vol. xxiii. p. 94.

Mr. Dawkins' arguments in favour of the "affinity" of the old Aquitanian cave-dwellers "with the Esquimaux" do not appear to be of the strongest value. "The habit of sculpturing animals on their implements" is common in all savage races; "the carelessness about the remains of their dead relatives" is also predicable of many; "the fact that the food consisted chiefly of reindeer" only proves that reindeer was an accessible and plentiful food, and by no means denotes community of origin. Mr. Dawkins' argument is:—All who eat reindeer meat are "closely allied:" Esquimaux eat reindeer meat, and Aquitanian cave-dwellers ate reindeer meat: ∴ Esquimaux and Aquitanian cave-dwellers are "closely allied." At the present moment, English, Americans, Negroes, and Red Indians are feeding here on beef (when they can get it): yet there is no community of race. Mr. Dawkins' last statement regarding the small stature being "proved in the people of the Dordogne Caverns by the small-handed dagger figured by Messrs. Lartet and Christy in the *Rêvue Archéologique*" I must doubt. All who are acquainted with the small-griped swords of the existing Hindoos, and of many of the so-called Phœnician sepultures, will know that they are held in the hand in a very different way to that of our own swords, and that the smallness of the grip by no means connotes the size of the individual. I must not, however, discuss this matter further in a periodical devoted to geology.

Mr. Dawkins accuses Professor Owen of holding "contradictory opinions." In opposition to the first, that "the Romans imported into Britain their 'already domesticated cattle,' and our breeds are

their descendants, he brings the statement that “*Bos longifrons* i
the only ox found in the refuse heaps, in not one or two but *all* th
camps, cities, villas, and cemeteries that bear the impress of Roma
civilisation in Britain.” In the first place, in one, at least, of th
Roman camps (London Wall) *Bos longifrons* is *not* the only ox found
as *B. frontosus* and *trochoceros* are associated with it. Whatever Mr
Dawkins may say of *Bos frontosus*, I presume he will not slump *B*
trochoceros in gurgite vasto of his *longifrons*. In the second place, I fai
to see how he can point out any difference between the characters o
the Roman cattle, which he nowhere describes, and those of *Bo*
longifrons, to which he is “unable to assign any characters of specifi
value.” Where one factor is unknown, and the other undefined, it i
difficult to perceive how any conclusion can be arrived at. Probabl
if Mr. Dawkins examines carefully a series of the bovine remain
from Italian sepultures, he may consider these also to be *longifrons*
This fact remains to be proved.

Mr. Dawkins' first conclusion, that *B. longifrons* “has not yet bee
proved to have existed before the Pre-historic age, in the bone-cave
and alluvia of which it is found abundantly,” I must leave him t
discuss with Professor Owen. His second conclusion, that “it is th
ancestor of the small Highland and Welsh breeds,” is self-evident
and unnecessary to be proved. I fail to see that Professor Owen'
original opinion to this effect needed such a repetition, nor do I se
any new arguments in favour adduced by Mr. Dawkins. When,
however, he employs the expression that “it is essentially the animal
with which the archæologists have to deal,” I must humbly put in a
plea in favour of the animal nature of man, and express my belief
that up to the present time I thought that archæologists had to deal
with human works, and human remains, as well as those of horses,
goats, and sheep, when found with human relics. For the present,
I must close this letter.

> “La plaza al punto el buey desembaraza
> Quedando stros mas bueyes en la plaza.”
> ARRIAZA.

C. CARTER BLAKE.

JAVALÍ MINE, CHONTALES, NICARAGUA,
4th December, 1867.

SILVER-FAHLERZ IN CORNWALL.

SIR,—Will you allow me space for a short reply to the letter of Mr. David Forbes contained in your last number? That gentleman seems to have quite misunderstood the object of my communication to the GEOLOGICAL MAGAZINE of December last (p. 575), upon which he comments. The explanation I have to give is as follows:—

Mr. Forbes having stated that “the cupriferous tetrahedrite (occasionally containing traces of silver) has been found in small quantities at various localities in both England, Ireland, Scotland, and Wales,” I believed he would be interested to know of the fact, that a cupriferous tetrahedrite, containing sufficient silver to render [illegible] of considerable commercial value, had been already worked in *large* [illegible]*antity* for some time past, at the Silver-vein mine in Cornwall.

Mr. Forbes has treated the results of various assays (made for commercial purposes) which I quoted, as if intended by me as evidence of this mineral being identical in composition with that from the Fox-dale mine, which would have been absurd. The figures were given solely for the purpose of showing that this ore contains certain quantities of silver; and I specially stated that I knew of no analysis having been made of it. Mr. Forbes will notice, if he refers to my letter, that I did not use the term polytelite at all, Glocker having proposed this name in 1847,[1] for a mineral analysed by Rammelsberg in 1846,[2] which not only contained between 5 and 6 per cent. of silver, but also from 36 to 38 per cent. of lead, with only 0·32 per cent. of copper (and which has been regarded by some mineralogists as an argentiferous *bournonite*). I do not believe the Cornish ore contains any lead.

The difference of opinion appears to arise from the question, as to what constitutes a silver-fahlerz; but I had not, nor have I now, the least intention to enter upon a discussion respecting tetrahedrite, and its many varieties, considerable difference of opinion existing as to the precise limits of the latter. It is quite possible that this ore (which is worked and sold in Cornwall as a silver and copper ore) may be an argentiferous tetrahedrite only; and that is precisely the point I hoped to induce Mr. Forbes to determine by analysis, and hence my letter. THOS. DAVIES.

P.S.—Since writing the above I have been favoured with a letter from Prof. A. H. Church, of the Royal Agricultural College, Cirencester, in which he says:—"I have found in one of my laboratory books the determinations of silver in Cornish fahlerz to which I alluded in conversation with you some time ago. They were made in August, 1865, for the purpose of ascertaining the value of the ore raised from the Silver-vein mine near Lostwithiel. The following were the results: ·73°|₀ Silver in a mixed sample of ore in coarse powder. 7·23°|₀ Silver in a crystallized fragment of fahlerz, having the density 4·85. 10·45°|₀ Silver in another crystalline mass."—T.D.

THE BELGIAN TERTIARIES.

SIR,—In the December number (p. 565), Mr. Godwin-Austen protests against the observations which I made on his paper on the Belgian Tertiaries, in my article in the GEOLOGICAL MAGAZINE for November last (p. 501). With regard to my objections, I can only assure him that I wrote them down in order to remove mistakes, and without the slightest intention of personally offending him. Mr. Godwin-Austen gives a list of fossils from the Cassel-beds (Upper Oligocene) in order to corroborate his opinion on their relative age. I am not aware now where this list is taken from, but that is of no consequence; but I must assure him that nearly all the names there cited are erroneous, according to the works of Sandberger (on the Mayence Basin), of Beyrich (Norddeutsche

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[1] "Generum et Specierum Mineralium Synopsis," by E. F. Glocker, Halle, Saxony, 1847, 8vo., p. 31.

[2] "Poggendorff's Annalen," vol. lxviii. 1846, p. 516.

Tertiær-conchylien), of Semper (Palæontologische Untersuchungen), and of Speyer (who has described and figured a large number of fossils exactly, from these beds in Palæontographica),—that is to say, according to all the important works published on that subject in the last ten or fifteen years. The opinion of Mr. Nyst, who of course is the best judge about Belgian Tertiaries, has been cited against me, but this was his former opinion; it is now quite in conformity with mine after the discoveries of the last few years. Lastly, I must repeat that it *is* possible, and therefore *necessary*, to divide the Tertiary deposits into far more than two, four, or six periods. It is of no consequence which names are adopted for them, whether the names Eocene, Oligocene, Miocene, and Pliocene are associated with Lower, Middle, and Upper, or whether we use the names given by Prof. Ch. Mayer at Zürich to all the different "Etages." A. von Koenen.

Marburg, Prussia, *20th Dec.*, 1867.

THE OUSE VALLEY.

Sir,—I am sorry that the mistake into which Mr. Searles Wood has fallen respecting the quarter-sheet 45 N.E., of the map of the Geological Survey of England and the Memoir thereon obliges me to request space for self-defence. Mr. Wood's charge is that I have omitted "*all reference* to the Glacial Clay." It is true that I have not sub-divided the Drift of that country into an upper clay and a lower gravel, because, as far as I could judge, I did not find evidence to support such a classification; but I have very distinctly stated that Boulder-clay is one of the forms which the Glacial deposits take (p. 53 of the Memoir), and have described sections where the clay is to be seen (p. 57). The Glacial Beds are not laid down on the published map because, as I have mentioned in the Memoir (p. 59), "additional surface maps are in course of preparation, on which the areas covered by superficial deposits will be marked out;" adding, what every one who has tried the experiment knows very well, that "it would be impossible, on the one-inch scale, to show these beds and the stratified rocks on the same map."

With respect to the sections on p. 34 of the Memoir, and p. 564 of your last volume, which Mr. Wood finds so different, I have only to state that the first has one scale for heights and another for distances, so that the former are exaggerated; the other is drawn to something like a true scale. In the one case too the outline of the supposed ancient valley is rashly drawn hard, and in the other indicated by a dotted line. The facts represented are exactly the same in each case, and I take it rather hard that I should be blamed because four years; experience has made me cautious and, may-be, rather a betterd raughtsman. I have no wish to set up my own limited experience, which I have urged in the Memoir (p. 58) as a reason for refraining from theorising, against the widespread and long-continued researches of Mr. Wood; but I do expect him, before he criticises, to do me the justice to read my memoir more carefully. A. H. Green.

Monk Bretton, Barnsley, *January 14th*, 1868.

THE
GEOLOGICAL MAGAZINE.

No. XLV.—MARCH, 1868.

ORIGINAL ARTICLES.

I.—On Dr. Sterry Hunt's Geological Chemistry.

By David Forbes, F.R.S.

In considering the mutual relations of the sciences of Geology and Chemistry, the student must always bear in mind which of these two sciences is to form the basis or starting point for his inquiry, for this cannot fail to exercise an important influence on his reasonings and deductions.

In what Dr. Sterry Hunt calls my Chemical Geology,[1] I have taken Geology as my starting point, and then endeavoured to apply chemistry, especially experimental chemistry, to the explanation of known geological phenomena. On the other hand, Dr. Hunt, in what may be termed his Geological Chemistry, starts from data purely chemical, and then looks around for geological instances to which they may be applied.

Thus, for example, starting from the chemical fact, that a solution of carbonate of soda will throw down carbonate of lime from a solution of the chloride of calcium, he at once asserts that the whole of "the calcareous strata, the marbles and various limestones which we find on the earth's surface," have been precipitated from the sea by a solution of carbonate of soda.

And again, Dr. Hunt observing in the laboratory that the reaction of the compounds of magnesia with carbonic acid in a dense atmosphere of that acid could be turned to account in facilitating the separation of Dolomites and Gypsums, at once jumps at the conclusion "that all magnesian limestones and gypseous strata from the most ancient up to the Tertiary periods were formed in a dense atmosphere of carbonic acid." Now in face of these assumptions, I contend and I feel confident the Geological world will bear me out, that no Geologist whosoever could in applying the study of Chemistry to the explanation of the phenomena of his science ever by any possibility have arrived at such sweeping generalizations.

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[1] Here it should be explained that Dr. Hunt, from having some time back published both in England and France an outline of his principles of Chemical Geology, has thereby fairly laid himself open to having his views both criticised and disputed; whilst, on the contrary, Dr. Hunt's knowledge of my views on this subject could be only derived from the allusions to my opinions scattered through the two papers relating to this controversy in the Geological Magazine of October 1 and the *Chemical News* of October 4 of last year. Although his virulent criticism might therefore be considered as hardly fair; still, so far from objecting to it, I feel truly thankful to Dr. Hunt for thus enabling me to strengthen the weak points, and inspiring me with more confidence than before in the *resumé* of the views on Chemical Geology put forth in a lecture to the Chemical Society, now in the press.

When the safety of Rome was endangered by the victories of Hannibal, the advice of Scipio to the Romans was to save Rome by attacking Carthage; and the papers of Dr. Hunt in the *Chemical News* of Jan. 17, and the GEOLOGICAL MAGAZINE of Feb. 1st, evidently prove that he is determined to pursue a similar course; yet I confidently trust with a different result, since in this case I believe the forces at command are fully adequate, both for offence as well as for defence.

In this discussion, however, much more trouble is likely to be caused to me by the method in which Dr. Hunt carries on his scientific warfare, and which seems to partake of the character of the country in which he resides, where the Indian system used to be, to worry out the enemy by skirmishing, but never to attack strong points; and the history both of scientific discussion as well as of nations has shown how very effective such a plan of operations may prove, even in the defence of a very weak cause.

For this reason, therefore, I have considered it wise to keep the main points under consideration as prominently in view as possible, and if possible not to allow the discussion to become so diffuse as to risk losing sight of them, which I fear the readers of Dr. Hunt's long communication may be likely to do. Acting upon this determination, therefore, I have in my reply to Dr. Hunt's paper in the *Chemical News* of Jan. 17, which also appeared in the GEOLOGICAL MAGAZINE of Feb. 1, given a plain and concise statement of the points, numbered 1 to 9, in which I have presumed to differ from Dr. Hunt's views; and as I now find nothing in his subsequent communication to the GEOLOGICAL MAGAZINE of February 1 which could in any way tend to shake my conviction of the unsoundness of these points, I must be content to wait until Dr. Hunt may condescend to bring forward new evidence in their defence.

If now, however, after a perusal of Dr. Hunt's paper in the February number of the GEOLOGICAL MAGAZINE, it is compared with his preceding communication in the *Chemical News*, it will be perceived, as the Editor of the GEOLOGICAL MAGAZINE has already observed, to be to a great extent the same, and in many parts even verbatim; and remembering Dr. Hunt's puerile accusation, that I, "for some unknown reason, withheld from the readers of the *Chemical News*" matter which I published in the pages of the GEOLOGICAL MAGAZINE, it is amusing to observe that Dr. Hunt has in like manner reserved for the readers of the GEOLOGICAL MAGAZINE several interesting observations which probably he may have considered (and with some reason) as beyond the capacity of the chemists who patronize the *Chemical News*,—among others, for example, the following: "As for the noble metals, whose compounds with oxygen are decomposed at elevated temperatures, their great volatility, as compared with earthy and metallic oxides, would *keep them in the* gaseous form till the last stage of precipitation of earthy oxidised matters, when by far the greater part of the globe was probably solidified. Hence we now find them in the earth's superficial crust." And a little further, "We cannot conceive anything else than the production of a homogeneous oxydized silicated mass, upon which, at a late period, would be precipitated the noble metals."

Chemists will not require any comments upon the above, for they are accustomed to regard Platinum, for example, as one of the most refractory bodies known, which, of course, cannot be the case now that Dr. Hunt has made this interesting discovery of its great volatility at a point at which silicates solidify; and further, they were not aware that the extreme refractory nature of the other metallic oxides had been so completely demonstrated, since some of them, at least, as Lead, Bismuth, Antimony, Molybdenum, etc., are not remarkable for that property; whilst geologists will not feel convinced from Dr. Hunt's mere assertion that the noble metals have from the beginning been in the earth's superficial crust, precipitated on to it from the skies like Jupiter's golden rain, but may also be inclined to believe that they may have been carried up from below.

The only important point which Dr. Hunt now advances is the courteous request for Mr. Forbes to explain "the intervention of water in all igneous rocks, which, as he declares, are outbursts from the still fluid interior of our globe." The above words do not exactly express my views, since I advance that igneous rocks have their sources in some "*reservoir or reservoirs*" of still fluid matter in the interior of the earth; and I would add that, by the actions of capillarity and heat, I see no difficulty in explaining the infiltration of the requisite amount of water for the supply of such a source. As, however, I could not even think of accusing Dr. Hunt of "unfamiliarity with geological literature," to use his own words, I could not suppose him ignorant of the writings of Daubrée, who, in Europe, at least, is regarded as somewhat of an authority on these subjects; Dr. Hunt will find this question fully answered by that gentleman, whose words are: "En résumé, sans exclure l'eau originaire, et en quelque sorte de constitution initiale, que l'on suppose généralement incorporée aux masses intérieures et fondues, M. Daubrée est porté à conclure de l'expérience ci-dessus relatée, que l'eau de la surface pourrait, sous l'action combinée de la capillarité et de la chaleur, descendre jusque dans les parties profondes du globe."

Always preferring, when possible, a reference to fact or experiment than to authority, I would advise Dr. Hunt, in order to form a conception of such strange action, to examine a common Gifford or other injector used to supply feed-water to a high pressure boiler, and he will soon perceive that the very forces which otherwise would prevent the entrance of the water into the boiler are the very means of forcing it in.

Dr. Hunt also asks me to remember "that the oldest known series of rocks, the Laurentian, consists of quartzites, limestones, and gneiss evidently of *sedimentary origin* and derived from still older sedimentary rocks." When I was in Canada, what little I saw of the Laurentian rocks did not at all prove to me that they had been derived from *still older sedimentary rocks*, but, on the contrary, whilst believing that the Laurentian gneiss, quartzites, &c., were of metamorphic sedimentary origin, I inclined to the conclusion that the materials of which they had been reconstructed had most probably been the *debris* of eruptive igneous rocks, and this view I have maintained since 1854 with regard to some of the analagous Norwegian rocks which Dr. Hunt claims to be Laurentian. To refresh my memory, however, I have read over the description of the mineral characters of the Laurentian rocks in the Report of the Geological Survey of Canada, pp. 22–49, but can find no evidence whatsoever to the contrary—and, therefore, without disputing the correctness of Dr. Hunt's assertions on points where he ought at least to be confident, I would ask whether this statement is founded on facts or on hypothesis.

Dr. Hunt devotes a whole page to what appears to be an inquiry, as to who first showed that water played a part in igneous action, a subject which may be of personal or historical interest, but which is quite irrelevant to the questions under consideration; for all geologists will persist, notwithstanding whatever Dr. Hunt opines to the contrary, in regarding igneous action as volcanic action and volcanic action as igneous action, nor can they suppose for a moment that any person, except one who never had seen a volcano in eruption, could be blind to the evidence of his senses and deny the co-association of vapours and gases with volcanic action;—that the results of Mr. Scropes' admirable researches should have been discredited and ridiculed and declared unchemical, should be a warning in future to chemists not to hazard such opinions without having studied the subject in the field as well as in the laboratory.

As Dr. Hunt brings forward the question of the density of quartz, I may here state, what I omitted in my paper in the *Chemical News*, that all arguments based on this fact are completely invalidated by the fact that the specific gravity of crystallised quartz out of true volcanic lavas is 2·6, or the same as that of the quartz in granite; and, further, that Mr. Sorby's examination of the quartz out of these lavas completely proves that it was crystallized out of the melted rock, and not, as Dr. Hunt would have us infer, merely entangled from the *debris* of originally sedimentary strata.

Having long occupied myself with the application of the microscope in geology, and repeated most of Mr. Sorby's experiments relating to this subject, I consider it superfluous to contradict Dr. Hunt when he accuses me of not understanding Mr. Sorby's views, being quite content with that gentleman having expressed himself decidedly to the contrary. I would recommend Dr. Hunt also to commence with the study of microscopic geology, and can well imagine his being disconcerted when, on opening the last number of the GEOLOGICAL MAGAZINE, he found a few lines from Mr. Sorby, quite sufficient to annihilate all the deductions he had so elaborately arrived at from the study of that gentleman's memoirs, with the object of making them serve his own purposes.

All the other points have been noticed in my recent communication to the *Chemical News*, and I would merely state here that as regards Dr. Hunt's criticisms upon my views it is probable that many of them would not even have been advanced by Dr. Hunt had he waited until the outline of my views on Chemical Geology, now in the press, had appeared, instead of selecting scattered and disjointed sentences for attack, without giving the context. Thus, for example, when he accuses me of being ignorant of the laws of diffusion, he would have found my opinions expressed as follows :—

"Whilst, on the one hand, the zones formed in the earth are considered to have possessed a somewhat stable or permanent character, those formed in the atmosphere would, on the contrary, be the reverse, for no sooner had the gasiform products forming them, by in the first instance obeying the impulse of gravity so overcome the counteracting tendency of the laws of diffusion of gases, than these latter would assert themselves, and, in process of time, entirely obliterate this arrangement."

And again, "as before stated, this arrangement would be gradually obliterated by diffusion, but, as the element of time is of vital importance in considering the effects of diffusion, it is imagined that, before being obliterated, this arrangement may have had considerable influence in modifying the chemical re-actions which took place at this period in the earth's history."

Dr. Hunt, whose knowledge of the laws of diffusion does not seem to include any appreciation of the importance of the element of time in their consideration, might just as well tell us that a lump of sugar could not reach the bottom of a tumbler of water because sugar will dissolve in water. As Dr. Hunt seems to have such respect for authorities on the subject, I will, with the greatest pleasure, submit the question, whether the above proposition is invalidated by the action of the laws of diffusion, to the decision of Mr. Graham, the great expounder of these laws, and abide by his verdict.[1]

In the discussion of new views, more is required than mere quotations from old authorities. What is specially wanted are facts and experimental evidence. It must also be remembered that much depends upon the mode in which authorities are made use of in such discussions, since it is often an easy matter to select passages, or disjointed fragments, from the published works of authorities, which may appear to support almost any view which may be taken of a subject under consideration.

Dr. Hunt, whose paper consists, in greater part, of references to numerous authorities, from the time of Thomas à Kempis down to that of Sterry Hunt, seems to be quite aware of this fact, as an instance or two will testify.

Thus, when Dr. Hunt quotes Hopkins in support of his views as to the consolidation of the molten sphere, he takes care not to inform his readers that Hopkins distinctly declares his opinion that the exterior was not the last to solidify, but would have consolidated before the interior had became entirely solid, a view which I have adopted on his authority, and which is diametrically opposed to Dr. Hunt's opinion that the surface of the earth immediately previous to its entire solidification was "a liquid bath of no great depth, surrounding the solid nucleus."

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[1] It must be remembered that these gases are supposed to be formed at an instant of general combination *in situ*, and not gradually gathered from the realms of space.

Again, although he finds it convenient to quote Forchammer in reference to some minor points quite beyond the limits of the present discussion, he seems to be quite unaware of the fact that the idea of the saline crust of chlorides, &c., which he ridicules my having adopted, was long before propounded by Forchammer, who made the calculation that the chloride of sodium in such a crust would have been fully sufficient to have clothed the entire sphere with a coating of salt some 10 feet in thickness.

And yet again when he refers to Sorby's experiments as proving many points in favour of his views, amongst others that quartz cannot be volcanic, *i.e.*, a product of igneous fusion in nature, his deductions are at once entirely put to rout by the few lines from Sorby himself, produced in my last communication to the *Chemical News*.

On the other hand, after a careful consideration of the various memoirs of Hopkins, Forchammer, and Sorby, along with a careful repetition of many of their experiments, I cannot discover any one single point inconsistent with the views I have advanced. I am also able to bring much evidence in their favour from the writings of Daubrée, Bunsen, Durocher, Phillips, and other men of eminence, whose opinions Dr. Hunt evidently considers of no importance.

To prove that it is better to stay at home in one's laboratory than to travel wide and far in order to study Nature's operations in the field (as recommended by Sir Charles Lyell and other eminent men), Dr. Hunt quotes Thomas à Kempis, to the effect that "those who make long pilgrimages rarely become saints." What we require, however, is geologists, not saints; and it is well known that a knowledge of the world acquired by travel is the best antidote to bigotry or one-sided opinions.

As I have previously explained, I was induced to enter into this controversy (which I am quite confident will do good to science, by ventilating some obscure points) by the special invitation, conveyed in writing, from Dr. Hunt "to have a friendly fight;" but I now find, if I may judge from the style of that gentleman's communications, both to the GEOLOGICAL MAGAZINE and *Chemical News*, that his idea of scientific discussion consists in an attempt to overwhelm his opponent with sneers and countless accusations of incompetency and ignorance,[1]—ignorance of chemistry, of geology, of petrology, mineralogy, microscopy, literature of the subject, etc., etc.; whilst at the same time he has not omitted to herald in his own views as what might be termed the quintessence of the combined "results of modern investigations in physics, chemistry, mathematics, and astronomy."

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[1] Dr. Hunt does not merely content himself with mere accusations of ignorance, for when disputing my assertion that "reactions of the compounds of magnesia with carbonic acid in an artificially compressed atmosphere of that acid," had long been employed on a large scale, he uses the words "here it becomes difficult to admit the plea of ignorance, which suggests itself for most of Mr. Forbes's previous errors and mis-statements." I may merely add that, since the appearance of Dr. Hunt's communication in the *Chemical News* of January 17, I have received various communications from Chemists and others, connected, or acquainted, with this manufacture, not only offering to supply more facts in corroboration of the truth of my

Would it not have been more wise, as well as more becoming, to have left to our readers the task of forming their own judgment upon these points after having weighed the evidence brought before them on both sides, in the course of this discussion.

Having no pretensions, like Dr. Hunt, either to being a saint, or even to be versed in saintly lore, I cannot cite Thomas à Kempis, yet I can, nevertheless, follow his example, and even at the risk of appearing still more uncourteous, I really cannot resist the temptation to remind him of the old saying,—passed into a proverb among laymen—that "Curses, like chickens, come home to roost."

II.—ON THE IGNEOUS ROCKS OF CHARNWOOD FOREST AND ITS NEIGHBOURHOOD.

By the late Rev. BADEN POWELL, F.R.S., F.G.S., formerly Savilian Professor of Geometry in the University of Oxford.

[This paper, written in 1859, has been obligingly communicated to the Editor by WARINGTON W. SMYTH, Esq., F.R.S., President of the Geological Society of London.]

THE geology of Charnwood Forest appears to have been first systematically investigated by Professors Sedgwick, Whewell, and Airy in 1833. A very brief notice of their labours by C. Allsop, Esq., is appended to the history of Charnwood Forest by J. R. Potter, 1842, as is also a valuable and detailed memoir on the geology of the district, by J. B. Jukes, Esq.

More recently the labours of the Government Survey have furnished us with the geological colouring of the Ordnance Map, and with several sections; accompanied by a few notes by H. Howell, Esq.

Since these researches I am unable to learn that anything has been published on this interesting region, which is admitted by Mr. Jukes to present many problems for investigation. In the very elaborate classified index of Mr. C. W. Ormerod, F.G.S. (1858), not a single instance occurs of any paper illustrative of the geology of this district, having been published in the Quarterly Journal of the Geological Society of London.

Having enjoyed an opportunity of residing upwards of two months in this region, during the summer of 1859, I examined and collected specimens from nearly every locality of igneous action. The brief notices here given have no pretensions beyond that of being faithful records of a few facts which fell under my notice, which do not seem to have been previously attended to, but which appear to bear on the questions still open to discussion, as to some of the geological features of this remarkable district.

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assertion, but also directing my attention to an expired patent, taken out many years ago (No. 9102, A.D. 1841) by the late Mr. Pattison, of Newcastle, in which these identical reactions are embodied.

Nomenclature.—The map of the Geological Survey marks *granite* at Mount Sorrel; *syenite* at Bradgate, Markfield, and other places. In the margin of the map they are both classed as *igneous* rocks. But in the Museum of Economic Geology, specimens from all (except Mount Sorrel, from which there is no specimen) are arranged under the name of *altered* rocks. Mr. Jukes describes them all as *syenite*. In the Museum there is a specimen described *greenstone* from Quorndon. This, I presume, is from the quarry in Buddon Wood, which is part of the Mount Sorrel mass. I have found specimens closely resembling greenstone in the Mount Sorrel quarries. In fact, among specimens collected from all these quarries, many are found exactly alike from the most distant localities, while, in the very same rock, varieties so distinct may be found that it might be described by the most different designations. Even in the same specimen there is often a transition from the most coarse-grained mottled white or pink syenite to the most compact mass resembling greenstone.

The nomenclature of igneous rocks has confessedly been ill-defined. But, perhaps, recent remarks rather lead to a general disregard of such distinctions, and to giving more prominence to the idea, so strongly supported by the researches of Mr. Marshall and others (British Association, 1858, and Prof. Phillips' address to Geol. Society, 1859), that they are all simply varieties of a very few primary types under different conditions of fusion.

Still there is the material question involved, how far any given rock is properly a deposit or sedimentary formation, remaining as such even though much dislocated and disturbed, but which has been altered in its constitution perhaps totally by the action of heat from below,—and how far it is an original fused or hypogene mass carried up, in a fused state, by eruptive action into its existing position among, and breaking through, other rocks. In the phenomena presented by the rocks of Charnwood and its neighbourhood there are, confessedly, many problems of this kind still open for investigation.

Localities of Igneous Action.—Commencing with the admitted purely eruptive masses of Mount Sorrel,[1] including the hills of Buddon Wood, adjoining to Quorndon, and several minor outbursts of the same syenitic or granitic rock, upon and adjacent to Mount Sorrel Common, indicating the general substratum,—we trace a remarkable continuous development of the same rock in a S.W. direction, at the top of Kirksley hill, along its side, at the farm, at its base, and lastly, at Brazil or Basil Wood, in the valley; within half-a-mile of the village of Swithland, and at about the same distance from the commencement of the slate district to the N.W.

Brazil, or Basil, Wood.—This locality is one of peculiar interest. The Geological Survey accurately marks three patches at this spot, as igneous.

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[1] The syenite of Mount Sorrel has yielded several minerals, amongst which may be mentioned Molybdenite (*sulphuret of Molybdena*), by no means of common occurrence in England. Associated with it, in the same quarry, occur copper and iron pyrites, the latter but sparingly distributed. These minerals appear to occupy definite planes, or points, in the syenite.—R. E. Geol. Mag., Vol. III., p. 526.

The first of these consists of what might to a casual observer seem merely a small heap of transported blocks in the New Red marl, but the larger blocks are deeply inbedded; the ground falls on every side from the mass: and it has the appearance of a true outbreak. These masses consist entirely of a dark syenite, coarse-grained, with large black crystals of hornblende.

The other two masses occur in the adjacent wood. They are both small knolls or hills, covered to the summit with the red marl, sufficiently thick at all parts to bear not only wood, but trees of considerable size.

In the most northernly of these knolls, small portions of rock everywhere project, consisting of a deep syenite, more closely grained than the former. Some blocks also occur of a pink hue; like that of Mount Sorrel.

Of the third mass, perhaps one half has been quarried away. The section shows the red marl, covering it to the top. The nature of this rock is peculiar; at some parts the pink syenite occurs, but only in thin beds, between the other portions, in variously inclined positions. In some parts, but very rarely, this syenite is full of glittering scales of mica, which it has been suggested to me indicate the action of heat by their peculiar appearance. This is the only locality in which I have found any mica; excepting minute specks of it which may be detected in some specimens from Mount Sorrel.

The great mass of the quarry consists of a very dark, compact, hard rock, largely used for road making, and esteemed by the workmen the hardest in the district. Throughout many portions minute, hard, and brilliant crystals are diffused. In some specimens they lie in bands or veins, while the rest is destitute of them.

At one part, in a kind of corner between two upheaved masses, a portion of the same rock is seen contorted, as in the annexed sketch. (Fig.1.) This dark rock, which seems unique in the district, has not, as far as I can find, been noticed. From an examination of my specimens it has been described to me as, probably, a micaceous slate, altered

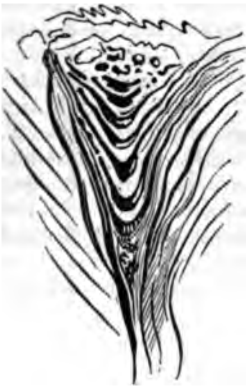

Fig. 1. Contorted Rock, Basil Wood.

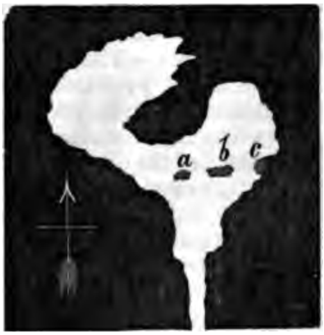

Fig. 2. Ground-plan of Quarry near Buddon Wood.
a, *b*, *c*, portions of Basaltic Dyke.

by contact with the igneous rock. If so, this locality exhibits a true junction of the slate and igneous rock, not hitherto detected.

Basaltic Dykes.—Mr. Jukes, in his Memoir (1842), has circumstantially described two basaltic dykes in the neighbourhood of Mount Sorrel. Neither of these can now be traced as described.

The first is mentioned in the quarry near the Buddon Wood, on the opposite side of the road. The ground plan of this pit is annexed (Fig. 2). It is situated in the slope of a hill, and opens level with the ground at the south end. The rock is everywhere syenite, like Mount Sorrel, except at the points marked *a*, *b*, *c*, where there rise up, from the floor of the pit, two small projections (*a*, *b*), of a dark brown, but not very hard, rock, much split and shattered, perhaps two or three feet in height and breadth, and extending six or eight feet in length; and at *c* a small buttress of the same rock projects from the wall, but no termination of it can be traced on the other side. The mass of the dyke has, doubtless, been quarried away since Mr. Jukes wrote.

The second dyke is described as existing in Simpson's pit, near the S.W. corner of Mount Sorrel Common. This small pit is not now worked. I found it (1859) filled up partly with rubble, partly with syenite, broken, and worked for paving. In this I could find no specimen of basalt. And, in carefully examining all the rock which appears round the margin, could detect no appearance of the terminations of any dyke. It must, probably, have been all quarried away like the first. Lest any mistake as to the locality should have been committed, I carefully examined every pit, or appearance of rock, in the neighbourhood, but could detect nothing like a basaltic dyke.

At quite the opposite side of the forest, near Markfield, in a pit at the cross roads, another dyke has been pointed out by Mr. Jukes, which is remarkable from the conformable manner in which the altered slate is superimposed on it. I found it to consist of an intensely hard, compact, dark grey mass, presenting, when exposed, a rounded surface, to which the slate conforms.[1]

Anticlinal Axis.—The anticlinal axis of the slate district was originally traced by Professors Sedgwick, Whewell, and Airy in 1833, in a line extending from near Whitehorse Wood at the N.W., to somewhere near Swithland Wood at the S.E. The more detailed examinations of the Government Survey have confirmed this general direction, but show the necessity for some modifications in its details. But the general resulting character of the elevation has not been clearly described.

In its northern portion the anticlinal axis is clearly defined running in nearly a straight line, for the most part in a continuous valley the hills on each side having opposing dips from the neighbourhood of Whitehorse Wood, in a S.E. direction as far as to near Bandon

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[1] In the extensive syenite quarry at Markfield, a vein of compact calcite occurs of considerable extent; it has a red or pink tinge, and possesses throughout the well-defined rhombic cleavage. It has been proposed to use this for economical purposes, owing to the extent of the vein and its pure character.

Castle. From this point, continuing still in the same direction, a boundary line is clearly marked, on the N.E. side of which the dip is still, as before, towards the N.E. as far as to the neighbourhood of Swithland Wood. But on the S.W. side of this line a different arrangement occurs. Throughout a considerable space of a triangular form, whose points are Bandon Castle, Hammercliff, and Greenhill, the direction of the dip *has not been ascertained*, probably from the few, if any, indications of rock, except those of igneous character, at the top of the hills just named, all the lower district being covered with the new red.

Continuing towards the S.E., commencing from Greenhill, we enter a district extending thence to Groby on one side, and to Holgate on the other, within which a *new direction of the dip* prevails, being, on an average, *almost uniformly at the S.E., or at right angles to the former directions.* This region includes the hills of Bencliff, Old John, and others. On the outside of this region, both (as already shown) to the N.E. and also to the S.W., the original opposing directions of the dip prevail, and extend, with few trifling irregularities, to the boundaries of the slate district on either side.

It would be important that the intermediate region just mentioned should be more closely examined, to discover, if possible, precisely where the change in the dip commences.

Relation of the dip to Igneous Action.—This remarkable disposition of the directions of the dip, and interruption of the regularity of the axis of elevation, seem to bear a relation to the localities of igneous action.

Along the whole N.E. side of the Forest generally, there are few or no indications of igneous, or porphyritic, rock, even among the most remarkably elevated and dislocated slate rocks. As we approach the axis towards its northern part, such indications occur, though sparingly; but, when we come to the *intermediate* region, the instances of igneous action become more frequent and remarkable, especially within that region, and, in some degree, outside of it. More precisely near the northern termination of the axis, in the valley under the S.W. side of Buck-hill, and further on, nearly in the same direction, at Long Cliff and New Cliff, developments of greenstone occur, but they do not rise to any elevation above the surrounding district.

In the same region, further to the S., in the valley under the S.W. bore of Beacon-hill, it is stated, in Mr. Allsop's notice, that Prof. Sedgwick detected a small manifestation of syenite; but it is not recognized in the Survey. I examined the locality described, answering to which there are two pits: one close above the farm called Alderman's Haw, which shows a close grained, dark grey rock, presenting little of the ordinary appearance of syenite, and more resembling porphyry; at another point, a little higher and more to the W., there is a larger mass of the altered slate rock. Of this another instance is marked in the Survey, on the top of Block's-hill, still more to the S.

Black-hill.—In the same region of N.E. dip, but somewhat S. of the point of commencement of the intermediate region, we have a locality marked in the Survey as one of feldspathic porphyry, at the summit of Black-hill, which offers a peculiar appearance, different from others similarly designated.

These all retain externally, at least at their upper parts, the usual jagged and split character of the slate, however altered and fused below. But Black-hill presents a very different appearance. To a casual observer the top of this hill (covered by a plantation) might seem merely over-spread with a collection of blocks; they are mostly of that comparatively smooth appearance, with partially rounded edges, which is totally different from the jagged structure of the slate. When more carefully examined most of these blocks are found to be deeply imbedded, and, in some instances, closely aggregated together. This seems allowed to constitute the evidence of their being a true porphyritic rock *in sitû*.

Intermediate region.—Recurring now to the region before mentioned, intermediate between the opposing dips, the first igneous locality which claims our notice is the hill on which is situated the farm called Bawdon, or Baldwin, Castle, which is marked in the Survey as syenite at the top, surrounded by slate, and on one side by the New Red marl.

On the body of the hill no rock whatever is visible; the whole surface being under cultivation, and covered apparently with the New Red marl, as most of the lower hills are.

In two fields, just below the summit, a few corners of rock project through the turf, and there are many scattered blocks.

Bawdon Castle.—At the summit, in the midst of that one of the two plantations nearest the farm, thickly overgrown with underwood, which renders it not easy to find, is a small knoll or mass of rock, consisting mainly of large pieces irregularly piled up. The specimens are so closely grained and compact as to resemble greenstone much more than syenite; as is the case also with some of the portions just below, before mentioned. Among these, however, and among the blocks, I found several specimens of the usual type of pink syenite, as well as others less marked, and approaching more nearly to the former character. In the museum of the Survey there is a specimen marked, "Greenstone from Bawden-hill," which, I presume, is from this locality. But, throughout the district, the names are most variously spelt and pronounced.

Line of Igneous action.—The most marked feature in the intermediate region, is the occurrence of several points of igneous action on the tops of the hills called Green-hill, Bencliff, and Old John, all lying *in a straight line* with each other, and with Black-hill, and *parallel to the axis.*

Out of this line, at a point near the S.W. base of Bencliff-hill, I have noticed another locality, not marked in the Survey, where there appears a mass of porphyritic rock, which seems to approach closely towards syenite in character, in a plantation by the side of the road, near the foot of the hill leading up from the Ulverscroft valley.

Old John-hill.—On the hill called Old John, one part is marked in the Survey as altered slate or feldspathic porphyry, of which there are specimens in the Museum, justly described as exhibiting great action of heat. But these characters are by no means confined to one spot, but are exhibited by various rocks about different parts of the hill, especially in a large mass of rock on that part immediately above Holgate, marked picturesquely by a gnarled oak growing out of the crevices.

These appearances of igneous action become more numerous as we approach the syenite of Bradgate.

Syenite of Old John-hill.—Besides a remarkable isolated mass of syenite, near the base of Old John-hill, close to one of the plantations of Bradgate Park, which, I believe, has not been described, there is, on the shoulder of the same hill, just over the village of Newtown, under a clump of trees, a remarkable collection of blocks of syenite. Some of these seem deeply imbedded. Are these merely transported and heaped on that one spot? or, is it not an analogous case to that of Black-hill—a true manifestation of syenite *in situ*?

Igneous action.—It is, theoretically, quite conceivable that a true igneous eruption might have vented itself with so little force as merely to break off, as the erupted matter cooled, in detached lumps, especially when under the sea, and be scattered over a small surface immediately adjacent, as in these instances; while it might have been only the same kind of action, in higher intensity, which protruded the heaps and knolls of rock at several other localities, and the larger and loftier hills in other places.

Following the indications of igneous action in this central region, as we approach its S.E. boundary, towards the syenite of Bradgate, we are naturally led to connect them, and to imagine that the igneous force, after expending itself while pent up, in elevating the slate by a regular fracture, producing the axial valley, with opposing dips along its sides,—in some cases altering the slate into porphyry when it came into closer contact, and even in one or two places itself finding a vent,—at the commencement of this intermediate region began to force up new matter, filling up the fracture with elevations, through which in some places the fused matter protruded, and at length terminated in exuding through a wider space about Bradgate and its neighbourhood.

It has been argued by some that rocks adjacent to igneous erupted matter, not altered or upheaved by it, must have been subsequently deposited. I do not see the force of this conclusion; for if we suppose the elevating, dislocating, and altering force to be that of the igneous action, *so long as it was pent up* beneath the superincumbent mass, then as soon as it found a vent the fused matter would be ejected quietly without injury to the adjacent rocks, like steam when the valve is opened.

Extension of axis.—The line of the axis has been traced to extend to the limestone region at Breedon, beyond the N.W. end of the slate region, and is nearly parallel to the great fault which abruptly bounds the coal-field of Ashby on the W. side towards Charnwood, as well as to other faults which traverse it.

These facts seem to show that through a considerable distance to the N.W. the same subterranean force operated, perhaps in still greater intensity, as is indicated by the violent disturbance and almost vertical position of the limestone at Breedon, and the enormous fault of 500 feet near Whitwick; and would accord with the fact of the absence of any indication of igneous eruption, or vent to the hypogene matter, in these regions.

Localities of igneous action S.W. side.—It is along the S.W. side of the Forest hills that the marks of igneous action are by far the most frequent and remarkable. There is, in fact, in this part one main line running nearly parallel to the anticlinal axis, along which they seem to follow a continuous series.

On the south side of the road leading from Newtown to Markfield I noticed a small pit displaying a porphyritic rock, approaching to Syenite. This I believe to be the most southernly point in this series or range as yet detected.

Continuing to the N.W. I have also noticed a small mass of a similar porphyritic rock, at the end of the same range of hill which at about half-a-mile further in the same line to the N.W. brings us to the remarkable ridge bearing the inviting name of Hammercliff, marked in the Survey as porphyritic or altered slate along its sides and ends, while the summit is an outburst of Syenite. There is a specimen of Greenstone in the Museum of the Survey from Copt Oak Farm, which lies just below the summit of this hill.

Pursuing the line of this range still to the N.W., we have the rocks of Birchwood plantation marked Greenstone in the Survey, but in the Museum named porphyritic Cambrian, which agrees much better with what I have noticed of its character. Further in the same direction occurs the similar rock (by whichever name designated), of Greenhill.[1] These ridges at length terminate further still in the same general line, in the extensive tract or elevated plateau bounded by the porphyritic or altered Cambrian rocks of High Towers and Tin Meadow, etc., on the south, and of High Sharpley and High Cadman, etc., on the north, including among the former those of Pedlar's Tor, which furnished the specimen of Crystaline Cambrian in the Museum of the Survey. In the midst of this elevated plain, with its horizon everywhere bounded by these jagged and fantastic forms of rock, amid partial attempts at enclosure and cultivation, stands the monastery of S. Bernard.

Character of altered rocks.—The extensive ranges of rock on the monastery hills are graphically described by Mr. Jukes as presenting all varieties and degrees of igneous action mixed in inextricable confusion. The specimens, however, which I have collected from various parts of this region all agree in exhibiting the same more or less grey porphyritic appearance and manifestly faded character.

Deposition of the New Red.—That the New Red marl throughout this district has been deposited *unconformably* upon the slate, and therefore *since* its *dislocation*, is palpable from the mere fact of the universally high inclination of the strata of the slate and the *comparatively* level position of the New Red.

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[1] A different hill from that before mentioned, bearing the same name.

But there are several localities where the New Red has clearly undergone some disturbance since its deposition. In the cases which I have observed, the inclination of the strata of the New Red, marked by distinct bands, does not amount to more than 12° or 15° measured on the surface of the section exposed. But the real dip may, of course, amount to any quantity greater than this. Sketches of a few cases are annexed. These are all instances of deposition over slate. Some cases where the New Red is deposited over igneous rocks have been before noticed.

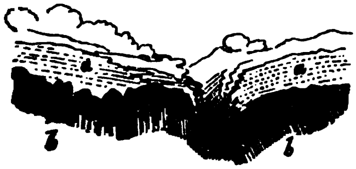

Fig. 3. Swithland Old Pit, reopened in 1859.

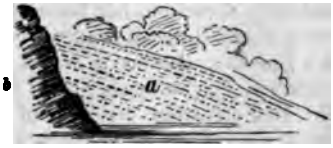

Fig. 4. Mr. Ellis's Pit, inner part, facing South.

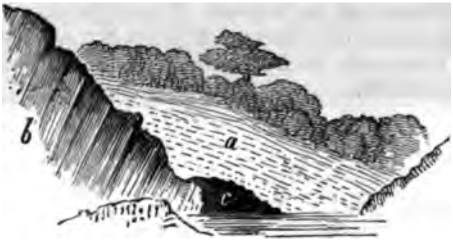

Fig. 5. Mr. Ellis's Pit, near the entrance. South-west side.
[a. a. New Red Sandstone. b. b. Slate. c. Cave. The letters *a* and *b* have the same reference in Figs. 3, 4, and 5.]

Other cases are those, for example, at Groby, mentioned by Mr. Jukes, and where I have seen a good instance of the horizontal deposition of the New Red, immediately over the syenite. Again, at New Cliff the New Red is undisturbed by the greenstone. The syenite hills of Buddon Wood are densely covered with trees, even at their summits, growing apparently out of no inconsiderable thickness of the New Red marl. This is more remarkably the case in the abrupt knoll, or ridge, which forms the top of Kinlesley-hill, the upper end of which is cut away by a quarry, and the whole bears large trees, the thickness of soil being exposed by the face of the quarry, though no distinct marks of stratification enable us to judge of its conformability. At the lower end of the knoll (which slopes towards Swithland) there is a small quarry, where the superposition of the New Red is still more apparent.

Connexion of Igneous Rocks.—The syenite or granite of Broadgate and Groby has been ejected over a considerable space, mostly without being forced up to any elevation above the surrounding region; but at Markfield, and in a less degree at Cliff-hill, it has risen in higher and isolated hills; while, on the same side of this district, standing apart to the westward, the greenstone of Bardon-hill attains the greatest elevation of them all, rising to 800 feet in an isolated peak, covered entirely with dense wood, e knoll, or ridge, at the top. These outbursts, which at a flank the S. and W. of the slate district, seem to be no connected with the similar developments at Mount So and E. Such a junction may, possibly, be indicated by ridge in the New Red sandstone, which reaches, nearly line, from Bradgate Park to Rotherby Plain, near along which, and in the valley below, blocks of Syenite co

The yet more probable extension of a similar rock, i southerly direction, has been inferred by Mr. Jukes, fr rence of small manifestations of it in the New Red, al in a line to a distance of about 15 miles or more, at K Enderby, Marborough, Croft, Sapcote, and Potter's Ma add, that a further distance, of nearly the same extent direction, brings us to Arbury-hill, near Daventry, at in the operations of the Trigonometrical Survey, Capt that remarkable deviation of the plumb-line of nearly which he attributes to an increase of gravitation at owing to the presence of a dense rock below the surface its probable connexion with "Mount Sorrel and o rocks" of this district.

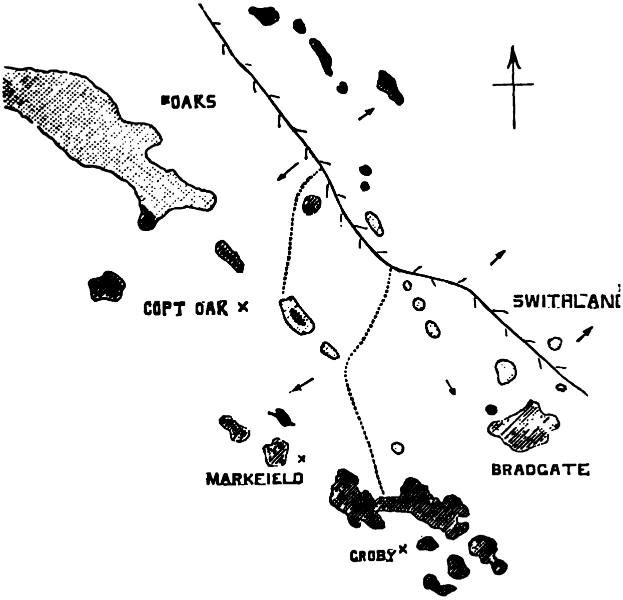

Fig. 6. Diagram of the Igneous Rocks of Charnwood Fore

▨ Altered Rock.

■ *Igneous Rock*

— *Dykes.*

→ *Average* direction of dip.

The line running from S.E. to N.W. indicates the direction of t

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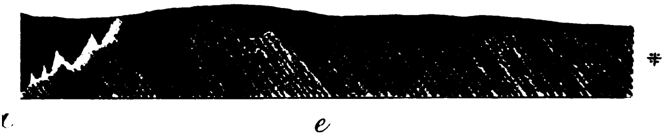
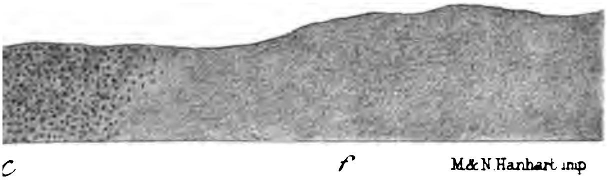


reen rock resting unconformably on



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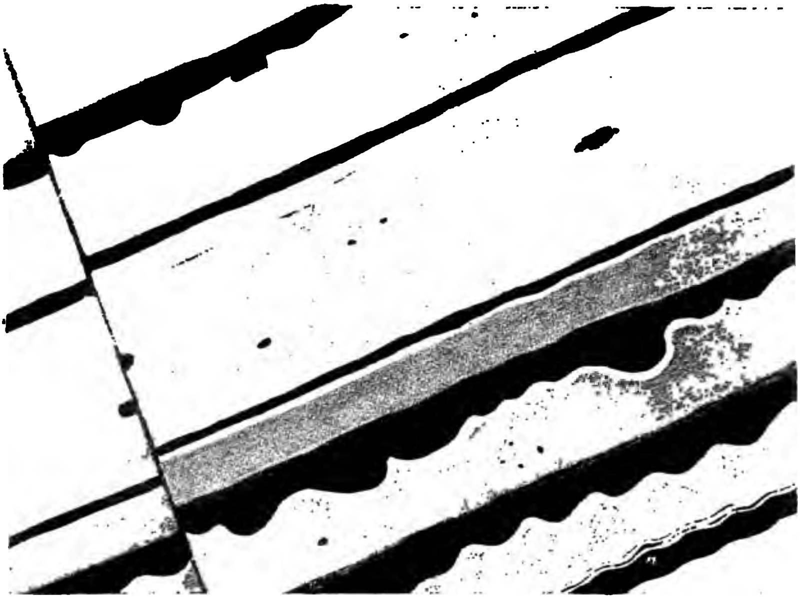

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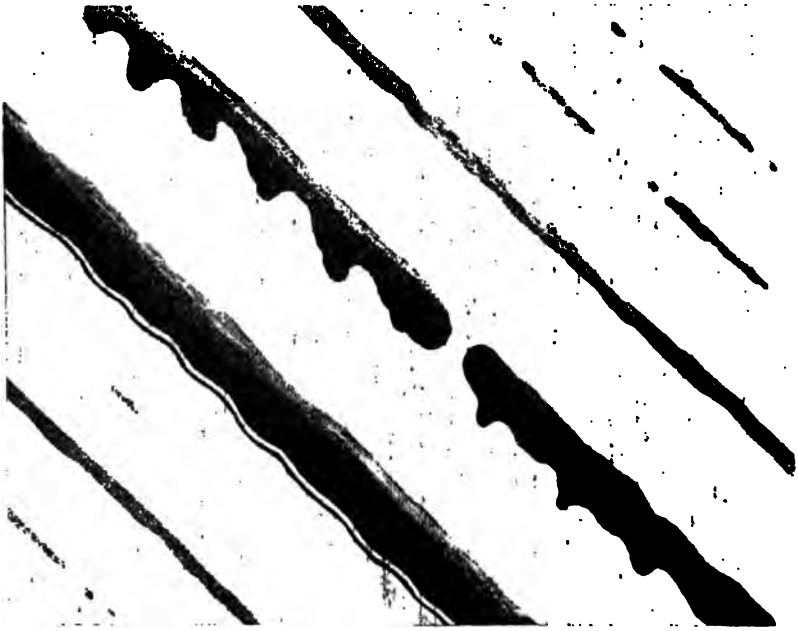

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III.—On a New Section of the Cambrian Rocks in a Cutting of the Llanberis and Carnarvon Railway, and the Banded Slates of Llanberis.

By George Maw, F.G.S., etc.

(PLATES VI. AND VII.)

THE importance of the question of conformity in the classification of the earliest stratified rocks induces me to give a short description of a new section of a part of the Cambrian rocks of Llanberis, exhibiting an apparent case of unconformity towards their base.

The section has only been exposed within the last few months, and at the time the district was mapped by Professor Ramsay, this complicated part of the series was hidden under a roughly weathered and glaciated surface, from which few of the details of structure could be determined. The railway in course of formation, along the southern side of Llyn Padarn, has exposed for nearly a quarter of a mile the lowest and most intricate part of the Cambrian rocks, a representation of which is given in Plate VI. A new tunnel in the neighbouring Glyn quarries has also opened up another section of the beds given in the engraving (see Woodcut, Fig. 1).

The upper part of the Cambrian series, not included in these sections, consists of three or four alternations of blue and purple slates interstratified with conglomerates and beds of a greenish rock. From the Lingula flags downwards they appear to be perfectly conformable; but the conformity of the lowest workable slates in the Glyn quarries, with the underlying beds, appears to me to be less certain.

These lower grits and conglomerates, which are visible on both banks of Llyn Padarn, graduate into the great mass of porphyry crossing its western end. The gradation and metamorphism of the beds is well seen beyond the north-western end of the cutting; but whilst the change of the conglomerates to crystalline porphyry, from east to west, is evident, the overlying workable slates of the Glyn quarries resting directly upon them are entirely unaltered at the point of junction. In the south-east end of the section (Plate VI.) two masses (*a a*) of the blue slates are faulted down between the underlying altered grits and conglomerates *b* and *c*, and the same thing is observable in the tunnel, Fig. 1. Irregular bosses of these underlying rocks, termed "Hards" by the quarrymen, rise up in several places among the purple slates, but whether this was solely due to faulting, or to the deposition of the slate on a pre-existing irregular surface of the metamorphic rock, is not easily determinable: the contortions in the latter do not, however, appear to be repeated in the overlying slate, and the irregular line of junction as seen in parts of the tunnel cannot, I think, be altogether accounted for by the faults that have thrown the porphyry and slates together.

Between 150 and 470 feet from the south-east end of the cutting,

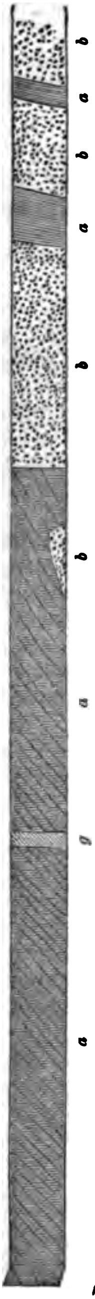

Fig. 1.—Section of New Tunnel in course of Excavation by the Glynrhonwy Slate Company, Glyn Quarries, Llanberis.

Represents a length of about 325 feet, beyond which the adit has been driven about 100 feet, through the metamorphosed conglomerate and porphyry. Blue slate reappears in the roof of adit at about 400 feet from the mouth.

a a a a Lowest workable blue slates. *b b b b* Metamorphic porphyry (altered conglomerate). *g* Greenstone dyke.

Horizontal Scale 50 feet to an inch.

the beds have a general inclination of about 45° to the south-east, and are much broken and contorted; they are of a dark greenish grey colour, faintly banded with dull buff, the stratification becoming less apparent towards the north-west; and at 475 feet from the south-east end of the cutting the dark green rock suddenly terminates, resting on the upturned edges of an older slate (*e* Plate VI.), dipping north-west, and of a different character to the workable slates of the Glyn and Dinorwic quarries.

The line of junction, given in Fig. 2, is clearly defined, the irregular outline of the slate (B) being bleached along the line of contact. The remainder of the cutting exposes a broken synclinal of this "bastard slate" interstratified with conglomerates (*c*), which at the north-west end graduate into the porphyry[1] (*f*). The synclinal trough of slate can be traced on the opposite side of the lake and appears identical with that marked 2·2 in Professor Ramsay's section (Fig. 53, page 144, Geology of N. Wales.) The slate marked 2′ is, however, I believe, not a repetition of 2·2, but corresponds with the higher bed of workable blue slates in the Glyn quarries, in which case the point corresponding with the unconformity on the south side of the lake would be somewhere between the figures 2 and 2′ in Professor Ramsay's section. The details of structure are, however, not so fully exposed here as on the south side.

The dark green rock (A Fig. 2, and *d* Plate VI.) resting unconformably on the "bastard" slate (B) in the railway cutting closely resembles, in physical character, the thin green bands interstratified with the blue slates (Plate VII., Figs. 1 and 2) of the Glyn quarries, and also the green beds separating the blue from the overlying purple slates. As some difference of opinion was expressed at the late meeting of the British Association regarding the character of these green layers, it may be well to notice one or two points in connection with their composition and mode of occurrence.

With reference to their chemical constitution, the following analyses made for me at the laboratory of the Museum of Practical

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[1] This gradation of the stratified beds into the porphyry is fully described in Professor Ramsay's work on the "Geology of North Wales."—G.M.

Geology indicate that it is very different to that of the blue slates:—

Analysis of the Dark Green Layers (the darkest portion represented in Plate VII.) interstratified with the Blue Slates, Glyn Quarries, Llanberis.

Silica	66·45	Potash	0·05
Titanic Acid	0·63	Soda	0·90
Alumina	13·38	Carbonic Acid	1·30
Protoxide of Iron	1·71	Combined Water	3·90
Peroxide of Iron	1·41	Hygroscopic Water	0·13
Protosesquioxide of Manganese	0·91		
Lime	2·86		99·91
Magnesia	6·28		

With traces of Phosphoric and Sulphuric Acid.

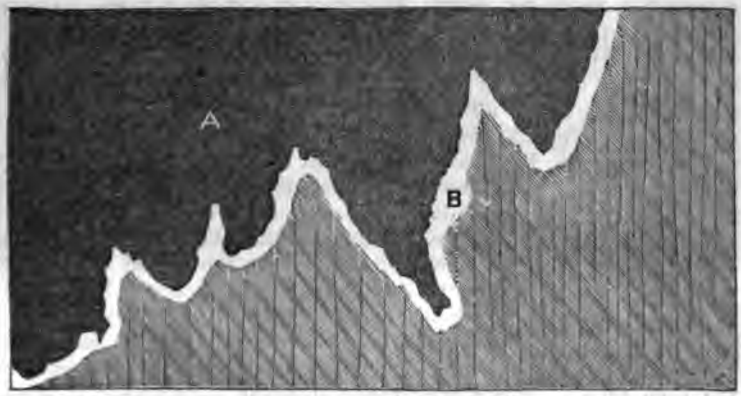

Fig. 2.—New Railway Cutting, Llanberis; corresponding with letters *d e*, on Plate VI.

The green rock (*d* Plate VI., A Fig. 2) resting unconformably on the "bastard" slate *e* contained 1·89 per cent. of magnesia and traces of titanic acid.

Analysis of Blue Slate (the middle tint in Plate VII.) interstratified with the Green Layers.

Silica	60·68	Soda	2·09
Alumina	21·20	Titanic Acid	0·59
Peroxide of Iron	5·68	Carbon	0·07
Protoxide of Iron	0·46	Combined Water	2·70
Protoxide of Manganese	0·16	Hygroscopic Water	0·18
Lime	1·71		
Magnesia	0·88		100·04
Potash	3·64		

With traces of Sulphuric Acid.

Mr. David Forbes, who has obligingly made sections for me of the green beds and slates and examined them under the microscope, informs me that "the slate appeared to be composed of a pretty uniform mixture of grains of quartz sand with ferruginous clay, both in fine division, and that the green bed was made up of quartz fragments with decomposed felspar and particles of red oxide of iron, and occasionally a greenish mineral in small quantity, probably chlorite."

It is evident from the analysis, that the slate and interstratified layers not only differ as to the state of mechanical subdivision of their constituents, but, notwithstanding the sudden and numerous alternations which often occur within a few inches, have a very different composition, and must have been derived from distinct sources of material. The most striking difference is in the proportion of the magnesia, of which the green layers contain seven times the amount of that in the slate, and the slate contains more than six times the amount of alkalies found in the green beds. Again, lime, magnesia, and protoxide of iron are much more largely present in the green beds than the slate, and a comparison of the two analyses, as well as the microscopic structure, conclusively show that the green bands could not have been derived by chemical segregation from the slate.[1] Moreover, the thicker bands contain mechanical fragments of a pale green slate. In the Glyn quarries (Plate VII.) they invariably range with the stratification, and appear to have been subject to all the movements and alterations the slate has undergone since its deposition; the adjacent slate, generally on the under side only, but sometimes on both the upper and under side of the band, has been changed to a pale green (the lightest portions of Plate VII.), and the isolated spherical blotches are of the same character, surrounding a small nucleus of the green matter.

As I have referred to the character of this pale discolouration in another paper recently communicated to the Geological Society,[2] I would here only observe that analyses of the bleached bands fail to support the view expressed by Mr. Sorby[3] that "they are concretions of a peculiar kind formed round bodies lying in the plane of bedding." Their general composition is identical with that of the blue slate in which they occur, differing only in the reduced amount of peroxide, with no increase of protoxide of iron present. Mr. Sorby has pointed out that these discoloured blotches have been much elongated and distorted in harmony with the lines of cleavage (Plate VII., Fig. 2), indicating that the discolouration was antecedent to the cleavage. The banding and bleaching has also been interrupted (as in Plate VII., Fig. 1) by the dislocations of the slate.

A strong proof of the contemporaneous interstratification of the dark green layers is that their upper surface, which is comparatively level, graduates into the overlying slate, as though in the deposition of the succeeding layers of mud, some of the green matter had been washed up and intermixed with it. The junction with the slate on the under side is, however, defined with remarkable precision, and instead of being nearly level it has a curiously undulating outline, pockets of the green rock here and there running down into the slate below. It seems difficult to explain why the green beds should thus graduate upwards into the slate, whilst the slate beds shew no gradation on their upper surface into the overlying green layer.

Another remarkable feature is that they are not horizontally continuous; the limits of many cannot be traced, but they also occur as isolated patches environed on all sides by the slate. The nuclei of the bleached spheres represent their smallest development, between which and the continuous layers patches of every intermediate size occur.

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[1] The view suggested by Professor Phillips at the late meeting of the British Association.

[2] "On the Disposition of Iron in Variegated Strata."

[3] "On Origin of Slaty Cleavage," Edinboro' New Philosophical Journal, July, 1853

The ultimate composition of the green beds would be consistent with their containing a large proportion of hornblende. Bischof[1] refers to beds of similar character interstratified with clay slates in the Thuringian Forest, and discusses the question whether they may not be a metamorphic product from the slates; but in the case of the Welsh slates, whatever be the source of the materials composing the green layers, whether simply detrital accumulations from eruptive rocks, or otherwise, their sedimentary interstratification is scarcely open to question.

The bleaching of the blue slate adjacent to the dykes of intrusive Greenstone seems to be of a different character to that adjacent to the interstratified layers. Instead of being defined by a distinct outline as in Plate VII., the pale colour graduates into the normal colour of the slate, and analyses of examples from the Penrhyn and Llanberis quarries indicated that the change of colour was due to the reduction of most of the iron from sesquioxide to protoxide, probably by the agency of a moderate degree of heat on the intrusion of the Greenstone. As I believe there is no published analysis of the composition of these Welsh Greenstones, it may not be out of place to give the result of a determination made for me by Dr. Voelcker for comparison with the composition of the green layers interbedded with the slate.

ANALYSIS OF GREENSTONE DYKE, PENRHYN QUARRIES.

Water of Combination ……	1·99	*Carbonate of Lime …………	14·85
Bisulphide of Iron …………	0·23	*Carbonate of Magnesia ……	14·59
Protoxide of Iron……………	10·22	Potash ………………………	0·43
Peroxide of Iron ……………	1·97	Soda …………………………	0·70
Titanic Acid…………………	2·51	Silica …………………………	47·47
Alumina ……………………	5·80		
Sulphate of Lime……………	0·08		100·633

* The carbonate of lime (and magnesia?) occurs for the greater part in the shape of separate crystals, which are visible in a fresh fracture to the naked eye, and effervesce in isolated spots on the application of hydrochloric acid.

IV.—A REVISION OF THE BRITISH GRAPTOLITES, WITH DESCRIPTIONS OF THE NEW SPECIES, AND NOTES ON THEIR AFFINITIES.[2]

By WM. CARRUTHERS, F.L.S., F.G.S., Botanical Department, British Museum.

(PLATE V. p. 64.)

Class, HYDROZOA. Order, *Graptolitida.*

GEN. I. RASTRITES, Barr. (Grapt. de Boh. p. 64). Polypary simple, consisting of a slender capillary common tube, supporting a single series of isolated hydrothecæ, which are free throughout their whole length.

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[1] "Chemical and Physical Geology." English edition, vol. iii., p. 315.

[2] Concluded from the February Number of the GEOLOGICAL MAGAZINE, p. 74.

Sp. 1. *R. peregrinus*, Barr. (Grapt. de Boh. p. 67, pl. 4, fig. 6), Loc. Moffat.

2. *R. Linnæi*, Barr. (loc. cit. p. 65, pl. 4, fig. 2-4). Common tube, very slender, supporting largish hydrothecæ, broad at the base and narrowing gradually upwards. From 10 to 15 in an inch, uniform in the same specimen. Plate V. Fig. 15. Loc. Moffat.

3. *R. maximus*, sp. nov. (Pl. V. Fig. 14). Common tube slender, supporting very large hydrothecæ at wide intervals. Hydrothecæ nearly half an inch long, somewhat enlarged towards the apex, and furnished at the base with a triangular corneous membrane extending a short distance up the margin of the cells. About 6 cells in an inch. Loc. Moffat.

4. *R. capillaris*, sp. nov. (Pl. V. Fig. 16). Common tube very slender, with short isolated triangular hydrothecæ, their base of attachment to the common canal as long or longer than their depth. About 16 cells to an inch. Loc. Moffat. Richter figures this specimen in Zeitschr. Deutsch. Geol. Gesellsch. V. 1853, Tab. xii. fig. 34 a., referring it to *R. gemmatus*, Barr., which is very different, and of which his fig. 34 b. is a good representation.

R. triangulatus, Harkn. (Geol. Journ. vol. vii. p. 58), was founded on portions of the proximal end of *G. convolutus*, His., as has been stated by several observers. It is remarkable, however, that this species of *Graptolithus* really terminates proximally in a polypary that cannot be distinguished from *Rastrites*. This was pointed out to me by Prof. Wyville Thompson in a specimen figured on Pl. V. Fig. 1, which Prof. McDonald found one day he joined me in the search for the fossils at Bell Craig, near Moffat. The specimen is now in Jermyn Street Museum. I have in my own collection a smaller specimen, which exhibits also both structures on the same organism. How far this may affect the stability of the genus *Rastrites* I cannot at present say. All the species are founded on comparatively small fragments, and it is possible that they may all be the proximal terminations of different species of *Graptolithus*.

R. Barrandi, Harkn. (Geol. Journ. xi., 475), was founded upon specimens of *Cladograpsus gracilis*, Carr., according to Prof. Harkness himself (GEOL. MAG. IV. p. 258).

Besides the forms enumerated, I have obtained several fragments agreeing with the figures of Richter's *Graptolithus urceolus* (Zeitschr. Deutsch. Geol. Gesell. V. 1853, p. 462, Tab. xii., fig. 29, 30), and with the specimens drawn on Tab. v. fig. 3 and 4 of Geinitz's "Graptolithen," which he refers to the lower portion of the stem of *R. triangulatus*, Harkn., but which are certainly the same as the forms figured by Richter. These fragments differ from *R. peregrinus*, Barr., in having a small portion of the free end of the hydrotheca bent at a right angle, the mouth being turned round so as to open in the direction of the proximal end of the polypary. This character is so marked that I would not hesitate to include it in *Rastrites*, as a true species of that genus as it is at present understood, were it not that I have hitherto met with it only in very short fragments; and these will be found, I believe, when more perfect specimens are obtained, to be the proximal terminations of a *Graptolithus*, agreeing in this respect with what I have described in *G. convolutus*, His.

GEN. II. GRAPTOLITHUS, Linn. (Syst. Nat., Ed. I.). Polypary simple, with a single series of hydrothecæ in contact throughout more or less of their length.

Sp. 1. *Nilssoni*, Barr. (Grapt. de Boh. p. 51, pl. 2, figs. 16, 17). Loc. Moffat.

2. *G. intermedius*, sp. nov. (Pl. V. Fig. 18). Polypary slender; proximal end composed of a slender canal with distant, isolated, and very small hydrothecæ; adult hydrothecæ, short, triangular, the upper margin of the cell forming an acute angle with the common canal. About 26 cells to an inch. This species differs from *G. Nilssoni*, *G. tenuis*, and *G. Hisingeri* in the form of the cells, and from the last also in the slender common canal. Perhaps Portlock's figure 6*a*. pl. 19 of his Report belongs to this species. Loc. Moffat.

3. *G. tenuis*, Portl. (Report of Geol. of Londonderry, p. 319, pl. 19, fig. 7). Loc. Moffat.

4. *G. Salteri*, Gein. (Die Grapt. p. 36), *G. tenuis*, Salter (Quart. Journ. vol. vii. p. 173, pl. 10, fig. 1). Loc. Girvan.

5. *G. Hisingeri*, Carr., *G. sagittarius*, His. et auct., non Linn. I have, in a

previous page, given the reasons for changing this name. Although so well marked a species, it has perhaps been more frequently figured and described as new than any other graptolite. To it I refer the following: *G. scalaris*, Gein. (Leon. and Br. Jahrb., 1842), *G. incisus*, Salter (Quart. Journ.), *G. tænia*, Sow. and Salt. (Geol. Journ. vol. v.), *G. Barrandei* Scharen. (Grapt. p. 15), *G. virgulatus*, Scharen. (Grapt. p. 14), *G. latus*, Roem. (L. and Br. Jahrb., 1855), *G. polyodonta* Roem. (*ibid*), *G. oblique-truncatus*, Roem. (*ibid*), *G. Jungsti*, Roem. (*ibid*), *G. serratus*, Gein. (L. and Br. Jahrb, 1842), *G. nuntius*, Richt. (Zeitschr. Deutsch. Geol. Ges., 1853), *G. laxus* Nic. (Quart. Journ. vi.). *G. rectus*, Emm. (American Geol. i.) is the same species, but it is erroneously drawn with the cells directed towards the proximal end. *G. Conybeari*, Portl. (Report, p. 320),—I cannot distinguish the authentic specimens in the Geological Museum, Jermyn Street, from *G. Hisingeri*. Loc. Moffat, etc.

6. *G. Flemingii*, Salter (Quart. Journ. viii. p. 390, pl. 21, figs. 5-7). Loc. Wigton.

7. *G. convolutus*, His. (Leth. Suec. p. 114, pl. 35, fig. 7). The following synonyms belong to this species *G. spiralis*, Gein. (L. and Br. Jahrb. 1842). *G. Sedgwickii*, M'Coy, not Portl. (Pal. Foss. p. 6, pl. 1B, fig. 2). *G. sagittarius*, Giebel (Die Silur. Fauna, pl. 6, fig. 11). *G. pectinatus*, Richt. (Zeitsch. Deut. Geol. Ges. 1853). *G. elegans*, Emmons (Am. Geol. i. p. 106). *Rastrites triangulatus*, Harkn. (Quart. Journ. vol. vii.). I have figured on Pl. V. Fig. 1 the most perfect specimen of this species I have yet seen. The importance of the specimen was pointed out to me by Prof. W. Thompson. The older portion of the polypary has the structure of *Rastrites*. The cells are linear and isolated. Each cell is furnished with two spinous processes from the sides of the mouth. Indications of these are to be seen in the specimen figured, but I have numerous other specimens in which they are more obvious, appearing as in Figs. 1*b*, and 1*c*. The first cells are long and slender, they gradually become shorter and thicker, and then they assume the triangular form characteristic of the full-grown polypary, with the bases extended so far along the common canal as to meet. Loc. Moffat, etc.

8. *G. Sedgwickii*, Portl. (Report, p. 318, pl. 19, figs. 1-3, 6). M'Coy having mistaken this species, has caused it to be confounded with *G. convolutus*. Harkness gives a very good representation of the species from Dumfriesshire specimens (Quart. Journ. vol. vii. p. 58). In the original description Portlock clearly distinguishes it from *G. convolutus*. He says: "The serratures are strong projecting hooks having a wide base."

9. *G. priodon*. Bronn. (Leth. Geogn. p. 56, pl. 1, fig. 13). *G. ludensis*, Murch. (Sil. Syst. p. 694). Loc. Ludlow, etc.

10. *G. Halli*, Barr. (Grapt. p. 48, pl. 2, fig. 12, 13, excl. fig. 14, 15). Loc. Moffat.

11. *G. Becki*, Barr. (Grapt. p. 50, pl. 3, figs. 14-18). *G. lobiferus*, M'Coy (Pal. Foss. p. 4, pl. 1B. fig. 3). *G. Nicoli*, Harkn. (Quart. Journ. vol. vii., p. 61.). *G. millepeda*, M'Coy (Pal. Foss. p. 5, pl. 1B, fig. 6). *Diplograpsus nodosus*, Harkn. (Quart. Journ. vol. vii., p. 63). Loc. Moffat.

12. *G. Clingani*, sp. nov. (Pl. V., Figs. 19*a*., 19*b*). Polypary, small and arcuate, with a broad common canal, and slender somewhat recurved hydrothecæ. This beautiful little graptolite I long supposed to be only the proximal portion of some other species, but the large number I have met with, all equally perfect, none larger than fig. 19*a*, and many showing the prolongation of the axis beyond the distal end, together with the great breadth of the common canal (forming two-thirds of the breadth of the whole polypary), unlike the early portion or proximal fragment of any graptolite with which I am acquainted, have induced me to consider it a good species. I have associated with it the name of my earliest friend, the late J. Morison Clingan, M.A., my school-mate and fellow-student, my companion in rambles over the green hills and among the picturesque valleys of our native district, in exploring its geology or enjoying its beauty, and my friend and counsellor until death early cut him off, but not until he had shown promise of great excellence in the literary pursuits to which he had devoted himself, and had endeared himself by his virtues to a large circle of friends.

13. *G. Griestonensis*, Nic. (Quart. Journ. vol. vi. p. 53). Loc. Peebleshire.

GEN. III. CYRTOGRAPSUS, Carr. (Murch. Sil., Ed. IV., p. 540).

Polypary growing in one direction from the proximal end, and giving off simple or compound branches at irregular intervals.

Sp. 1. *C. Murchisonii*, sp. nov. (Table V. Fig. 17*a*, 17*b*). Hydrothecæ triangular apiculate, furnished with a spine. The upper margin of the cell at right angles to the axis, about twenty-eight cells to the inch. The polypary is considerably incurved at its proximal end, and as it grows it gradually opens into a larger curve. The branches spring from celluliferous surface of the polypary, but as there is no break in the continuity of the hydrothecæ, they must rise from the periderm covering the common canal. The branches also curve in the same direction as the main portion of the polypary. Loc. Pencerrig, Builth. I have associated the name of the author of "Siluria" with this remarkable species. The only British specimens I have seen are in the Geological Museum, Jermyn Street, but among the specimens obtained by the British Museum from M. Barrande there is a specimen from Listice, labelled *G. priodon.*, which belongs to this species.

2. *C. hamatus* (*G. hamatus*, Bail. I. Quart. Journ. Geol. Soc. Dubl., 1861, pl. 4, fig. 6). This remarkable form, of which I believe only a single specimen has been found, now in the Museum, Jermyn Street, where I have examined it, probably belongs to this genus.

Gen. IV. Didymograpsus, M'Coy (Brit. Pal. Fossils, p. 9). Polypary growing bilaterally from the initial point, consisting of two simple or bifurcate branches and without a central disc. The initial portion of the proximal end forming a non-celluliferous process always proceeding from the common canal or axis; the opposite or celluliferous side of the polypary frequently ornamented with one or more teeth or spines. The branches of the polypary sometimes extend at right angles to the initial process (*D. hirundo*), sometimes they are bent backwards upon it (*D. Moffatensis*), and less frequently they are turned inwards from it (*D. Murchisonii*).

The forms with bifurcating branches for which Salter proposed the genus *Tetragrapsus* do not differ in any essential character from the type of *Didymograpsus*. The precise number of branches is not taken into account in his genus *Dichograpsus*, in which there are species with eight, eighteen, etc., branches; and if of no value there, it can scarcely be employed here. It is not easy indeed to discover any character whereby to separate *Dichograpsus* from this genus, except it be the corneous disc that envelopes the non-celluliferous proximal portions of the polypary, which has never been found associated with specimens of *Didymograpsus*, and only with certain forms of *Tetragrapsus* and *Dichograpsus*. But this disc is not always present even in those graptolites in which it is known to occur; it may have been more perishable than the polypary itself; perhaps, however, the species which originally possessed it may be distinguished by other characters, as by the possession of an obvious branching hydrocaulus. There are, unfortunately, no materials in this country to enable one to determine this; but if this character should prove a good one, it would enable us to class the various forms into two well marked genera; some species of *Tetragrapsus*, such as *G. (T.) Headi* and *G. crucifer*, belonging to *Dichograpsus*, while *G. (T.) bryonoides*, etc., would be placed in *Didymograpsus*.

Sp. 1. *D. hirundo*, Salt. (Quart. Journ. xix. p. 137, fig. 13*f*). *D. constrictus*, Hall (Grapt. Quebec Gr. p. 76). Polypary of two branches, diverging at right angles from the initial points, and having its full size from the beginning. From 22 to 26 cells in an inch. Loc. Skiddaw Slates.

2. *D. Murchisonii*, M'Coy, *Graptolithus Murchisonii*, Beck (Sil. Syst. p. 694, pl. 26, fig. 4). *Prionotus geminus*, His. (Leth. Suec. Suppl. 2, p. 5, pl. 38, fig. 3). Loc. Llandrindod, etc.

3. *D. V-fractus*, Salt. (Quart. Journ. xix. p. 137, fig. 13*e*). Polypary of two branches bent inwards, forming an acute angle but speedily opening, and widely diverging from each other. From 20 to 24 cells in an inch. Loc. Skiddaw Slates.

The amount and direction of divergence of the branches are so variable in some well-marked species of this genus, as might be expected in polyparies composed of a flexible substance, that I doubt if specific characters of value can be deduced from them.

4. *D. sextans*, M'Coy (Pal. Foss. p. 9). *G. sextans*, Hall (Pal. of N. York, vol. i., p. 273, pl. lxxiv., fig. 3). Loc. Moffat.

5. *D. Forchhammeri*, Baily (Grapt. of Meath, etc., p. 6, fig. 7). *Cladograpsus Forchhammeri*, Gein. (Die Grapt., p. 31, pl. v. figs. 28–31). Branches of polypary slender, divaricating in straight lines, and at a wide angle, bent backwards towards the initial point. Hydrothecæ not very marked, in contact throughout almost their whole length; about 28 in an inch. Initial process permanent: the two first cells developed at a right angle to it, their mouths furnished each with a very fine short spine; a third similar spine proceeds from between the bases of the two primary cells opposite to the initial process. Loc. Moffat, and Kilnacreagh, Co. Clare.

6. *D. elegans*, sp. nov. (Pl. V., Fig. 8, *a b c*). Branches of the polypary divaricating at various angles, and with a slight curve within a short distance of the proximal origin of the polypary. The hydrothecæ are rounded at the apex, and free throughout a considerable portion of their length, and the intervening spaces are rounded at the base; about 22 cells in an inch. The initial process is obvious in young specimens, but I have not been able to detect it in old individuals; the outer apex of the angle ornamented with 3 short strong spines. Loc. Moffat.

Dr. Nicholson has enabled me to refer his *D. flaccidus* (GEOL. MAG., Vol. IV., p. 110, Pl. VII., Figs. 1–3) to this species. His fig. 1 has a general resemblance to Hall's *G. flaccidus*, but the form and number of the cells and the breadth of the polypary are very different. In Hall's species there are "from 28 to 30 and near the base sometimes 31" cells in the space of an inch. In Dr. Nicholson's drawing, "nat. size," there are 14! The figs. 2 and 3 made me fancy that he might mean the species I have just described, but it would have been impossible, except on his own authority, to have settled the matter. Loc. Moffat.

7. *D. Moffatensis*, Carr. (Trans. R. Phys. Soc. Edin., 1858, p. 469, fig. 3). *G. divaricatus*, Hall (Pal. N. York, vol. iii. pt. 1, p. 514, 1859). *D. anceps*, Nicholson (GEOL. MAG., Vol. IV., p. 110, Pl. VII., Figs. 18–20). The last paragraph in Dr. Nicholson's description of this species shows that he had overlooked *D. Moffatensis* when he wrote it, and his comparison of his fossil with Hall's figure puts it beyond a doubt that I have rightly placed *D. anceps* here as a synonym. Loc. Moffat.

8. *D. caduceus*, Salt. (Quart. Journ. vol. xix., p. 137, fig. 13). *G. Bigsbyi*, Hall (Grapt. Quebec Gr. p. 86). Hall has to my mind clearly shown this to have four branches. Loc. Skiddaw Slates.

9. *D. bryonoides*.—*Tetragrapsus bryonoides*, Salt. (Quart. Journ., vol. xix., p. 137, fig. 8*a*). *G. bryonoides*, Hall (Grapt. Quebec Gr. p. 84). Loc. Skiddaw Slates.

10. *D. quadribrachiatus*—*G. quadribrachiatus*, Hall (Geol. Surv. of Canada, Rep. 1857, p. 125). *Tetragrapsus crucialis*, Salt. (Quart. Journ., vol. xix., p. 137, fig. 8*b*). Loc. Skiddaw Slates.

GEN. V.—DICHOGRAPSUS, Salt. (The Geologist, iv., p. 74). Polypary compound, growing bilaterally, and branching more or less frequently in a dichotomous manner, the hydrocaulus, or non-celluliferous bases of the branches invested with a corneous disc.

Sp. 1. *D. octobrachiatus*,—*G. octobrachiatus*, Hall (Canada Rep. 1857, p. 122; Grapt. Queb. Gr. p. 96, pl. 7, 8). *D. aranea*, Salt. (Quart. Journ. xix., p. 137, fig. 9). Loc. Skiddaw Slates.

2. *D. Sedgwickii*, Salt. (Quart. Journ. xix. p. 137, fig. 11). Loc. Skiddaw Slates.

GEN. VI.—CLADOGRAPSUS, Carr. (Trans. R. Phys. Soc. Edin., 1858, p. 467). Polypary compound, growing bilaterally from the primary point irregularly, and repeatedly branching and rebranching, and without a central disc. *Pleurograpsus*, Nicholson (GEOL. MAG., Vol. IV., p. 256).

Sp. 1. *C. linearis*, Carr. (Trans. R. Phys. Soc. Edin., 1858, p. 467, fig. 1). *Pleurograpsus linearis*, Nich. (l. c.) This species has a slender polypary, and cells so slightly elevated as not to be clearly seen without the aid of a lens; there are about 18 to the inch. Dr. Nicholson's figure, "nat. size," represents a strong polypary with well-marked cells, and from 6 to 9 in an inch! I have no doubt that it was drawn as Dr. Nicholson says for this species, but it is greatly to be regretted that such drawings are published; they can serve only to increase the difficulties that under the most favourable circumstances beset every scientific investigation. Loc. Moffat.

2. *C. capillaris*, sp. nov. (Pl. V., Fig. 7 *a*, *b*) Extremely slender polypary, with remote branches, and very minute hydrothecæ; about 24 in an inch. It is not so abundant as *C. linearis*, and is very easily distinguished by its capillary appearance. It is probably the same species as that figured and described by Emmons in his American Geology, vol. i., p. 109, pl. 1, fig. 7, under the name of *Nemagrapsus capillaris*. Loc. Moffat.

3. *C. gracilis*,—*G. gracilis*, Hall (Pal. N. York, i. p. 274, pl. lxxiv, fig. 9); *Rastrites Barrandei*, Harkn. Loc. Moffat, and Bellewston Hill, Meath.

GEN. VII.—DENDROGRAPTUS, Hall (Grapt. Quebec Gr. p. 126). Polypary compound, with a thick common hydrocaulus giving off branches irregularly, which repeatedly subdivide in a dichotomous manner.

Sp. 1. *D. furcatulus*, Salt. (Mem. Geol. Surv. iii., pl. 11. *a*, fig. 5).

2. *D. lentus*, Carr. (Murch. Sil., Ed. iv., p. 541, fig. 5). Branches of the polypary repeatedly dichotomising; hydrothecæ acute-angular, about 18 in the inch. This is a much more robust species than that described by Salter. I have seen no more of it than the well-marked specimen figured (Pl. V., Fig. 5). Loc. Fermanagh.

GEN. VIII. DIPLOGRAPSUS, M'Coy (Pal. Foss., p. 7). Polypary with a double series of cells on either side of a slender axis. Hydrothecæ distinct from the periderm of the common canal.

Sp. 1. *D. pristis*, His. (Leth. Suec. p. 114, pl. xxxv. fig. 5), *D. foliaceus*, Murch. (Sil. Syst.) *Fucoides dentatus*, Brongn. (Hist. Veg. Foss. I. p. 70). *D. physophora* Nich. (Ann. Mag. Nat. Hist., January, 1868, p. 56). *D. vesiculosus*, Nich. (ibid p. 57). This is the best known and most abundant species of *Diplograpsus*. Although it has been frequently figured I have had four specimens drawn on Pl. V., with the view of illustrating the different forms of the appendages at the proximal end. The species generally appears as if it terminated in an acute point, formed by the approximation of the two primal cells; occasionally a spine continuing the line of the axis, and two lateral ones, are found (13 *b*, *c*, *d*), and in one specimen (13 *a*) I have observed two long slender processes rising together from the proximal points of the polypary, and produced apparently by the abnormal division of the medial spine. The axis is generally prolonged at the distal end, and is sometimes twisted and enlarged as described by Barrande (Grapt. de Boh. p. 4), and figured in different species of *Diplograpsus* by Barrande, Geinitz, Baily, etc. Dr. Nicholson has founded his *D. vesiculosus* on a specimen with the axis in this condition, and *D. physophora* is evidently another specimen of the same species in accidental contact with a "grapto-gonophore," or some other body. Loc. Moffat, etc.

2. *D. minutus*, sp. nov. (Pl. V., Fig. 12, *a*, *b*). This agrees with *D. pristis* in general appearance, and in the form and arrangement of the cells, except that the whole polypary and all its parts are so very small. Had I met with only a few specimens, I would have considered it as merely an accidental variety, but I have seen so many, all agreeing in size, that I cannot doubt that it is a good species, especially as young specimens of *D. pristis* early attain their full breadth, and the increase of the polypary is by additions to its distal end, and not to the size of the already formed hydrothecæ, just as in the living *Sertulariadæ*. About 38 cells to one inch. Loc. Moffat.

3. *D. angustifolius*, Hall (Pal. N. York III., p. 515, figs. 1 and 2). *D. acuminatus*, Nich. (GEOL. MAG., IV., p. 109, Pl. VII., Figs. 16 and 17). Loc. Moffat.

4. *D. persculptus* (Cat. Foss. Mus. Pract. Geol. p. 25). Beautiful specimens of this species, which I recently saw in the Woodwardian Museum, Cambridge, convinced me of its distinctness. It is nearly allied to *D. pristis* and *D. folium*.

A satisfactory description and drawing of it would be of value. Loc. Gogofau, Carmaerthenshire.

5. *D. Whitfieldi*, Hall (Pal. N. York, iii. p. 516, fig. i.). *D. quadri-mucronatus*, Nich. (GEOL. MAG. IV. Pl. VII. Fig. 6). This species I had long considered to be a mucronate form of *D. pristis*, with which species it for the most part agrees, except in the possession of the spines proceeding from the cell mouths. In the drawings, Pl. V. Fig. 3*b* and 3*c*, the spines are represented by somewhat too strong lines; their direction, which seems in life to have been at right angles to the direction of the polypary, depends in the fossil upon the way in which they have been pressed before or during fossilization. The direction is different on the two sides of Fig. 3*c*.

6. *D. mucronatus*, Hall (Pal. N. York i. p. 268, pl. 73, fig. i.), Pl. V. Fig. 2. Loc. Moffat.

It is not easy to determine how far the processes from the mouths of the hydrothecæ are to be depended upon for specific characters. Mr. Baily, from Irish specimens, has figured under the name of *D. mucronatus* (Grapt. of Meath, etc., fig. 4 *a*, *b*, *c*), a remarkable form, with the general aspect of *D. pristis* and *D Whitfieldi*, but with several branching and apparently anastomosing processes from the cell mouth. I have met with the same form at Moffat, and figured them in the Intellectual Observer, May, 1867, pl. I, fig. 6; and Hall, also, in his Graptolites of the Quebec group, pl. B. fig. 10, gives a drawing of a somewhat similar structure. He considers the processes to be the marginal fibres of the reproductive sacs, the sacs themselves having been removed (by maceration). The discovery of additional specimens may show that it is really a new species; and should it turn out to be so, I would suggest that it be called *D. Bailyi*, after the palæontologist who is doing so much towards the illustration of the palæozoic fauna of Ireland. The polypary has been very flexible, as bent and twisted specimens have occurred both to Mr. Baily and myself.

7. *D. tricornis*, Carr. (Trans. R. Phys. Soc. Edin. 1858, p. 468, fig. 2). *G. marcidus*, Hall (Pal. N. York iii. p. 515, figs. 1-3). When I described this species I had not detected the mouths of the cells in those specimens in which they should have been shown on the upper surface. In more perfectly preserved specimens since obtained these have been beautifully shown (Pl. V. Fig. 11*a*). I have given a drawing (Fig. 11*b*) of the early state of this graptolite. I drew attention to this early form and figured it in the Physical Society's Transactions for 1858, and in the Annals and Magazine of Natural History for January, 1859. In the third volume of the Palæontology of New York, published in 1859, with the dedication dated September, 1859, Prof. Hall figured the early state of the same species, p. 508.

8. *D. cometa*, Gein. (Grapt. p. 26, pl. 1, fig. 28). *D. tubulariformis*, Nich. (GEOL. MAG. Vol. IV., p. 109, Pl. VII. Figs. 12-15). This is a remarkable species, which should, perhaps, be made the type of a new genus. Geinitz's figure is very imperfect and fragmentary; an excellent figure is given by Richter in the German Geol. Society's Zeitschrift (1853, pl. xii. figs. 16, 17). I have given (Pl. V. Figs. 4*a*, *b*, and *c*) drawings of three different forms. These faithful drawings by Mr. Hollick may be compared with Dr. Nicholson's figures quoted, and some idea may be formed of the value of his illustrations; but his own drawings supply materials for their condemnation, for in his enlarged drawing of Fig. 14 he has made the 8 cells of the "nat. size" into 10, and in fig. 15 the 4 cells in the "nat. size" become 6 in the enlargement, so increasing not only their *size* but their *number* also.

GEN. IX. CLIMACOGRAPTUS, Hall (Grapt. Quebec Gr. p. 111). Polypary with a double series of cells hollowed out of the common epiderm.

Sp. 1. *C. scalaris*, Hall (Grapt. Quebec Gr. p. 111), *Graptolithus scalaris*, Linn. (Skanska Resa, p. 147), *Prionotus scalaris*, His. (Leth. Suec. p. 113). *G. palmeus*, Barr. in part (Grapt. Boh. pl. 3, figs. 5 and 6). *G. nuntius*, Barr. in part (*ibid.* pl. 2, figs. 7 and 8). *G. Halli*, Barr. in part (*ibid.* pl. 2, figs. 14 and 15). *G. personatus*, Scharen. (Grapt. p. 15, pl. 1, fig. 12). *G. teretiusculus*, Salt. (Quart. Journ. viii. pl. 20, figs. 3 and 4). *Diplograpsus rectangularis*, M'Coy (Pal. Foss. p. 8, pl. 1 B, fig. 8). *D. pristis*, var. *scalariformis*, Baily (Grapt. fig. 2 *a*, *b*, *c*).

From the time of Hisinger until Hall restored the name, this species was greatly misunderstood. It is a misfortune that cannot now be corrected, that this, the only species which Linnæus describes, finds a resting place in one of the most recently established genera, instead of being the type of the genus *Graptolithus*. Loc. Moffat, etc.

2. *C. minutus*, sp. nov. (Pl. V. Fig. 10*a*, *b*). This is a very minute but well-marked species, never attaining a greater size than represented on the Plate. There are at the rate of from 32 to 40 cells in the space of an inch. Loc. Moffat.

3. *C. bicornis*, Hall (Grapt. Quebec, Gr. p. 111). Loc. Moffat.

4. *C. bullatus*,—*Diplograpsus bullatus*, Salt. (Quart. Journ. vii., p. 174, pl. x., fig. 2). Loc. Piedmont Glen.

I have never seen a specimen of *D. pennatus*, Harkn.; it probably belongs to this genus, if it be not founded upon two mono-prionidian forms accidentally placed back to back.

GEN. X. DICRANOGRAPTUS, Hall (Grapt. Quebec Gr. p. 57). Polypary in the proximal portion, with a double series of cells, but dividing distally into two branches, with a single series of cells in their outer aspect. Hall describes this genus as having the structure of *Climacograptus*, as regards the cells in which the polypites were lodged, but in the two British species the polypites are certainly lodged in true hydrothecæ. The form of the polypary, however, supplies sufficient characters for the separation of the group as a distinct genus.

Sp. 1. *D. ramosus*, Hall (Grapt. Quebec, Gr., p. 57). Loc. Moffat.

2. *D. Clingani*, sp. nov. (Pl. V., Fig. 7 *a*, *b*, *c*). Polypary with a short diprionidian portion, the proximal end furnished with three very delicate spines; hydrothecæ forming a slight serration along the margin; 21 cells in the inch. Loc. Moffat.

GEN. XI.—RETIOLITES, Barr. (Grapt. Boh., p. 68). Polypary without a solid axis, cells arising from a central common canal in a double series, and in contact throughout their whole length. Polypary reticulated on the outer surface.

In *Dicranograptus* the double septum and axis become separated in the branches into their elements, forming a closed back and axis to the two mono-prionidian polyparies. The structure of *Diplograpsus* is exactly that of the proximal portion of *Dicranograptus*, being theoretically, if not actually, composed of two mono-prionidian polyparies, united back to back. In *Climacograptus* the filiform axis alone remains, and the divisions between the polypites is carried down to the axis, leaving, however, a continuous free space on either side of the axis for the common cœnosarc. In *Retiolites* this union is still more complete, the cœnosarc of the colony being common to the two series of polypites by the total disappearance of the axis and dorsal portion of the epiderm in *Graptolithus*, or axis and septum in *Diplograpsus*.

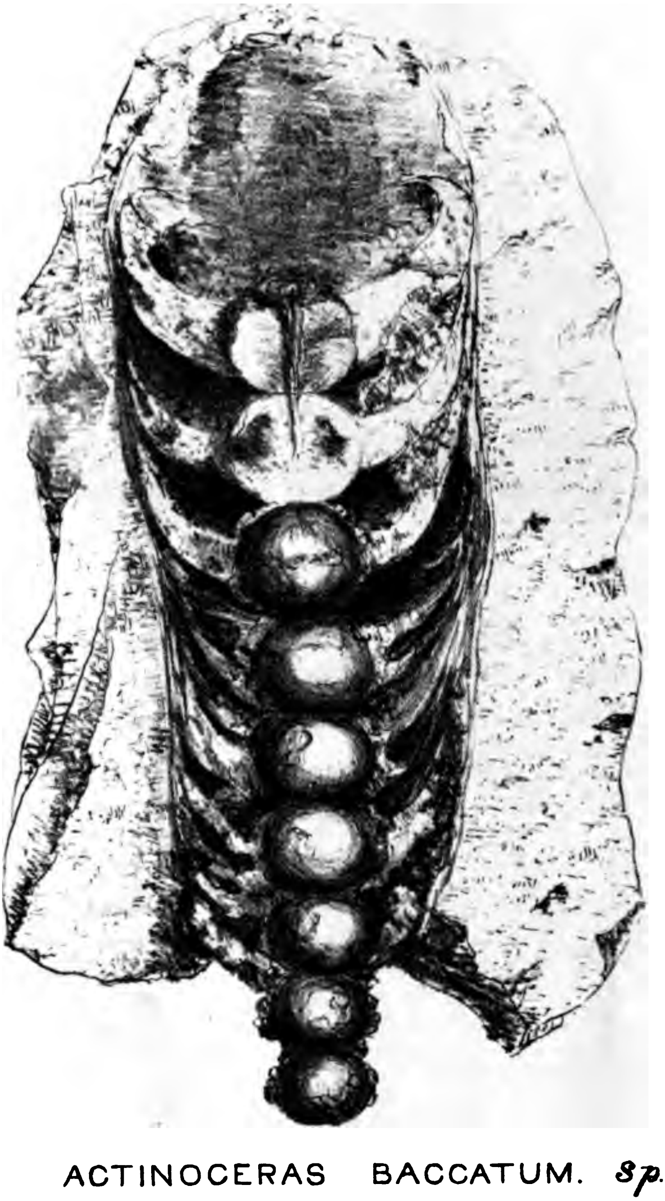
Sp. 1. *R. Geinitzianus*, Barr. (Grapt. Boh., p. 69). (Murch. Sil., Ed. IV., p. 541, fig. 2.) Loc. Cumberland.

2. *R. venosus*, Hall (Pal. N. York ii., p. 40, pl. 17 A., fig. 2). Loc. Cumberland.

GEN. XII.—PHYLLOGRAPTUS, Hall (Canada Geol. Report, 1857, p. 135). Polypary consisting of four laminæ of cells united rectangularly by their longitudinal axes.

The British specimens of this genus which I have seen exhibit only thin films on the surfaces of highly indurated or somewhat metamorphosed rocks, sufficient to determine their relation to Hall's genus, but utterly insufficient to exhibit any details of the remarkable structure of the genus. If I rightly understand Hall's descriptions and figures, the individual polypites in this genus are entirely separated from each other, the septa between the hydrothecæ being united to the periderm and continued to the axis. This structure is so anomalous among the *Graptolitidæ* that I am inclined to think that I misunderstand it, especially as Hall does not

Geol. Mag. 1868. Vol. V. Pl. VIII.



ACTINOCERAS BACCATUM. *Sp. nov.*

Woolhope Limestone, - Little-Hope Quarry, Woolhope.

distinctly describe it, although it seems to me to be necessarily implied in his figures and descriptions.

Sp. 1. *P. angustifolius*, Hall (Canada Rep., p. 139; Quart. Journ., vol. xix, p. 137, fig. 7). Loc. Skiddaw Slates.

V.—ON *ACTINOCERAS BACCATUM*, A NEW SPECIES OF ORTHOCERATITE FROM THE WOOLHOPE LIMESTONE.

By HENRY WOODWARD, F.G.S., F.Z.S.

[PLATE VIII.]

THE fossil about to be described was obligingly sent to me by Dr. Bull, of Hereford, having been happily rescued from the remorseless hammer of the road-mender, by Richard Johnson, Esq., the Town Clerk of that city. It exhibits the shell in section, fractured longitudinally, and embedded in a hard compact mass of dark blue Woolhope Limestone, which may be seen well exposed *in situ* in the Little Hope quarries, near Woolhope, from whence the block which contains the fossil was derived. Dr. Bull informs me that the Woolhope Limestone from these quarries is always used for road-metal in the surrounding district.

It is most faithfully delineated (of the natural size) in the accompanying lithograph (Plate VIII.), by the able pencil of Dr. Bull.

The fossil has been fractured so as to remove the upper surface, exposing seven perfect and two fractured beads of the siphuncle, and giving evidence of ten septa; the chambers formed by which remain partially hollow and are partly filled by calcareous spar. None of the exterior wall is visible from which the nature of the ornamentation of the shell, if any, might have been ascertained, but the interior portion is so characteristic of the genus that I have no hesitation in referring it to *Actinoceras*.

That genus is characterized as follows:—"Siphuncle very large, inflated between the chambers, and connected with a slender central tube by radiating plates."[1]

Of the species referred to this genus five are British, namely,

Actinoceras	*Brongniartii*, Portl.	Lr. Silurian,	Tyrone.
,,	*Brightii*, Sowerby,	U. ,,	Malverns.
,,	*nummularium*, Sowerby,	,,	Tortworth.
,,	*giganteum*, Sowerby,	Carb. L.	Yorkshire, etc.
,,	*pyramidatum*, M'Coy,	,,	Ireland.

The Woolhope fossil most closely resembles *A. pyramidatum*, of M'Coy, both in the beaded form of the siphuncle and the general proportions of the chambers, but the beads of the siphuncle are much less spherical in *A. pyramidatum*, and the sides of the chambers form a less acute angle at their junction with the outer wall of the shell than in the fossil before us.[2]

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[1] See "Woodward's Manual of the Mollusca," p. 58.

[2] Compare figure on Plate VIII. with M'Coy's figure in Carbonif. Foss. of Ireland, table *l*, fig. 5; see also Barrande's "Syst. Silur. de Bohême (Cephalopoda)" vol. ii., pl. 232, fig. 11.

The following are the proportions of the Woolhope specimen :—

Extreme length of siphuncle composed of 9 beads, 4¼ inches: transverse diameter of largest bead of same, 9 lines; vertical thickness of same, 7 lines; transverse diameter of smallest bead, 6 lines; vertical thickness of same, 4 lines; greatest diameter of shell, 2 inches; least diameter of shell, 1 inch 4 lines; interspace between one septum and another in largest chamber, 6 lines; in smallest, 3 lines.

Neither the apex or body-chamber of the shell being present, we can only surmise its length. A section of *Actinoceras giganteum* (?) from Derbyshire, preserved in the British Museum, measures 2 feet in greatest length and 3⅞ inches in greatest breadth, and exhibits thirty-eight body-chambers. An *Orthoceras* from Ireland, in same collection, measures 2ft. 10½ inches in length and 16in. in circumference. Many have been discovered even far larger than these.

To this group, undoubtedly, belong the most gigantic forms of the straight *Nautilidæ.*

The interest attaching to this most ancient group of chambered shells is such, that I have gladly availed myself of Dr. Bull's kind proposal to notice it in the pages of this Journal, accompanying the notice with his excellent figure. I have not only carefully examined the specimen myself, but have been favoured with the opinion of Professor Morris thereon, and I am confirmed in the conclusion that the Woolhope specimen is specifically distinct from any other heretofore described. I have therefore (at the suggestion of Dr. Bull) named it *Actinoceras baccatum* (in reference to the beautiful bead-like structure of the siphuncle).

The characteristic fossils obtained from the Little Hope quarries in the Woolhope Limestone from whence *A. baccatum* was derived are: Trilobites—*Illænus Barriensis, Homalonotus delphinocephalus,* and *Phacops caudatus.* Mollusks—*Orthoceras annulatum, Strophomena depressa, S. euglypha, S. pecten, Rhynchonella Wilsoni,* and *R. Stricklandi, Cirrus* — sp.; and also *Cornulites serpularius* and *Ptychophyllum patellatum.*

The Little Hope or Scutterdine quarries (which are quite *beneath* the Wenlock shale) are intersected by the Geological Survey, section No. 2 on sheet 13, and their precise position is laid down on the Ordnance Map No. XLIII., N.W.

It is to be hoped that the Woolhope Naturalists' Field-club, which numbers some excellent geologists among its members, will detect further specimens of this interesting fossil, and that we may be able, at a future day, to add a more full description to the present very brief notice.

MAMMALIAN REMAINS AT ILFORD.—Mr. Antonio Brady, F.G.S., of Maryland Point, Stratford, has again, at great expense, endeavoured to save from destruction some fine remains laid bare a few days since by the workmen in Hill's Pit, at Ilford. The remains included two fine pairs of horn-cores of *Bos primigenius,* a fine antler of *Cervus Elaphus* (with eight prongs), and a grand tusk of *Elephas primigenius,* measuring 9 feet 6 inches in length. Large numbers of loose limb-bones and vertebræ of *Bos,* and bones of *Ursus* and *Equus,* were also obtained.

NOTICES OF MEMOIRS

GEOLOGY OF THE SOUTH-WEST OF ENGLAND.

1.—"ON THE MIDDLE AND UPPER LIAS OF THE SOUTH-WEST OF ENGLAND." BY CHARLES MOORE, F.G.S.

Reprinted from the Proceedings of the Somersetshire Archæological and Natural History Society. Vol. xiii. 1865-66.

2.—"ON ABNORMAL CONDITIONS OF SECONDARY DEPOSITS WHEN CONNECTED WITH THE SOMERSETSHIRE AND SOUTH WALES COAL-BASIN; AND ON THE AGE OF THE SUTTON AND SOUTHERNDOWN SERIES." BY CHARLES MOORE, F.G.S.

Quarterly Journal of the Geological Society, December 1, 1867. Supplementary No.

IN the first of these papers, Mr. Moore describes the beds between the so-called Upper Lias Sands and the zone of *Ammonites raricostatus*, the highest member of the Lower Lias, in their passage through Somersetshire into Gloucestershire. He gives numerous sections, and lists of fossils, with descriptions and illustrations of the Mollusca,—some of which are new species. A typical section at Ilminster, showing 158 feet of Middle Lias, and 10 feet of Upper Lias, is first explained, and then compared with other sections in the South-west of England. The beds of the Middle Lias consist of irregular thickly-bedded marlstones, marls, and sands, with much ironstone. The Upper Lias comprises thin beds of clay and limestone, crowded with organic remains. Though iron is plentifully distributed in the Middle Lias of the district under consideration, the beds are not quite thick enough to be worked with profit.

In noticing the Ichthyosauri of the Upper Lias, Mr. Moore remarks that whilst these reptiles appear in Liassic times to have fed on the naked cephalopoda, others of this family in their turn retaliated. In several instances their bodies have been found covered by colonies of Ammonites, which were evidently preying upon the Ichthyosauri before they were finally entombed.

Mr. Moore discusses the recent classification with the Upper Lias, of the Yellow Sands beneath the Inferior Oolite, and states that he has never been able to recognize this arrangement. Not only is there in each horizon as distinct a fauna in its general facies as can be found in any other formation, but wherever the junction of the sands with the Upper Lias is observed, there is a most marked and permanent lithological distinction in argillaceous beds crowded with Ammonites, etc., capped by yellow sands, with but few evidences in their lower beds of organic life. Moreover, he adds, that wherever the junction of the Upper Lias with the Sands is exposed, the former presents an eroded surface.

Mr. H. B. Brady contributes a synopsis of the Foraminifera; and Mr. Henry Woodward furnishes a communication on the Crustacea, wherein he points out the interesting fact that many forms, common to the Lias, agree in identity with species found only in the Lithographic stone of Solenhofen, showing that they must have migrated before the close of the Liassic period in this country, and thus have been enabled to live on during the deposition of the long series of sedimentary deposits which occur between our Lias and the Upper Oolite in Bavaria.

2.—In the second paper, Mr. Moore shows that south of Bath there is a very remarkable thinning-out of the Secondary beds as compared with their equivalents beyond the Mendips, and that whilst in the latter case they attain an aggregate thickness of 3320 feet, in the neighbourhood of Radstock, Paulton, and Camerton they are reduced to 169 feet, which he considers to arise from the Mendip Hills having been a land-area during a great part of this lengthened period, and so serving to prevent the incursion of the Secondary seas within its borders.

The mineral veins of the district show most conclusively that the Carboniferous Limestone must for a very long-extended period have been within the influence of the Liassic seas, and that from the latter have been derived most, if not all, of their mineral treasures, whether iron, lead, or calamine.

Mr. Moore's observations lead him to the conclusion that the elevation of the Mendips and their South Wales continuation may be assigned to a time not far removed from the deposition of the Upper Beds of the Trias or New Red Sandstone. His discovery of a basaltic dyke in the Mendips clearly explains to him the origin of the up-heaval and disturbance of the beds forming this range of hills. A section across the Nettlebridge valley shows that by the protrusion of the dyke rocks of enormous thickness have been carried bodily forward in a northerly direction for a great distance, and are not only left standing vertically, but are in some instances folded over upon themselves. In consequence of this, Coal has been able to be worked beneath a reversed band of Carboniferous Limestone.

In regard to the Sutton Stone, Mr. Moore is of opinion that its peculiar lithology is only local, and he shows that these beds are truly Liassic—a view corroborated by Mr. Bristow's detailed observations in the field. Mr. Moore notices many points of palæontological interest, especially the wonderfully rich fauna of Brocastle, from which he has obtained nearly 200 species, including many Corals which have been examined and described by Dr. Duncan.—H.B.W.

REVIEWS.

CATALOGUE SYSTÉMATIQUE ET DESCRIPTIF DES FOSSILES DES TERRAINS TERTIARES, AU MUSÉE FÉDÉRAL DE ZURICH. CAHIERS 1 AND 2. PAR CHARLES MEYER.

THIS work appears in the Quarterly Journal of the Nat. Hist. Society of Zurich, but its value as a contribution to Palæontology is far greater than its unpretending and somewhat fragmentary mode of publication would imply. It is the result of critical study of species by an experienced and accomplished conchologist, and promises in the sequel to supply materials by which the Faunas of the various Tertiary basins may be compared: under which, that of the Swiss valley will be as interesting as any.

M. Meyer still adheres to the old Geological term "Tertiary," and includes the great Nummulitic series, in all its equivalents; but he shows in the sequel where and why a line should be drawn, which would detach the Nummulitic from the true Kainozoic series, or that of which every part contains some proportion of living forms.

In his Catalogue of species of fossil shells M. Meyer does not proceed according to any systematic arrangement. His first part comprised the Chénopides, the Strombides, and the Ficulides. In Part 2 are the Mactrides, and the Pholadomyides. Numerous species are reviewed, as to their range vertically, and their geographical distribution. Other columns, such as that of the money value of a specimen, or, again, that of its relative abundance or scarcity, might have been dispensed with.

To each Part of the Catalogue a Geological Introduction is prefixed. In his last M. Meyer proposes to make two additions to his previous scale (Tableau synchronistique des Terrains Tertiares, 1865),—the one quite at the base of the series, between the "Danien" and the "Suessonien;" the other, now the 12th, between the "Tortonien" and "Astien." The first of these is to include a fauna which has recently been discovered below any former subdivisions of the Belgic Nummulitic group; the other for certain beds which he had formerly considered as forming the lower portion of the "Astien" stage, but which he has now separated, in accordance with the views of M. Séguenza. Few geologists will agree with M. Meyer that this addition to the already long series of his "Tertiary" stages makes that period of more importance than either the Jurassic or the Cretaceous; but most will go with him in this—that they render more desirable than ever that the "Tertiary" period should be formed into two symmetrical and natural groups.

M. Meyer disposes summarily of older Geological arrangements. What, he asks, is the Pliocene? A simple stage, like any other; based, in Italy, on the preceding stage, and connected with neighbouring stages by so large a portion of its fauna, as hardly to retain a characteristic species. What is the Miocene? A jumble of four distinct stages, stratigraphically considered, of which the first (Aquitanien) has in common with the uppermost (Tortonien) but certain living species, and a few which make their appearance from the Tongrien period. What is the Oligocene? Three stages which occur in the little North German Tertiary basin, and which are joined together, because there accidentally is a break both above and below them, but the which are more completely distinct from one another than the lower and the higher are from those which precede or follow.

"But since it would be well to establish one or two great sections in the over-long Tertiary Series, it seems to me that there is a method of separation which above every other has the advantage of being convenient and perfectly symmetrical.

It is the method proposed by M. Hœrnes, which places the boundary line between the Eocene and the older Miocene, or between the Tongrien and Aquitanien stages. Let the Prussian geologists say what they may, it is precisely then—at the close of the Tongrien period—that in Europe the most important changes took place, either with respect to the displacement of seas, or the change of fauna. At that time, in the north of Europe, the sea retired from the whole of the English, French, and Belgic portions of the Tertiary basin, and there was a contraction of one-third of the North German basin. In central Europe there was a general and important elevation, or at least a first marking of the boundaries, of the whole Alpine chain; evidenced by the presence of Tongrien depositions on the mountains of Faudon and St. Bonnet, of the Dent-du-Midi, the Diablerets, the Titlis, &c., and by the position of the earliest marine deposits, of the Aquitanien period, at the base of the great Alpine wall. In the S.W. of France there was a contraction and emptying of that basin, as shown by depositions either wholly fresh-water or brackish. Palæontologically considered, there was nearly a complete disappearance, in the Aquitanien stage, of all the Eocene species, that is of those which still in considerable numbers connect the Tongrien with the subjacent stages; there was a complete extinction of Nummulites, which are still accumulated in great numbers in the upper beds of the Alpine and southern zones of the Tongrien stage;—(St. Jacques near Rennes, Gaas, le Tuc-du-Saumon near Dax, Faudon, Argentines in the French Alps, the Dent-du-Midi, the Diablerets, Acqui, Cassinelle, Pietra-Bissara, etc., in the Piedmontese Apennines; Verona, Castel-Gomberto;)—lastly the first appearance of the great Pachyderms, and swarms of still-living species of Mollusca."

It is true that M. Meyer suggests certain Palæontological considerations which may detract from the value of this proposed line of demarcation, such as an admixture of fossil in certain localities, just as was supposed to be the case at the Bolderberg; of such difficulties as these the physical geologist sees an obvious explanation. The Nummulitic group must be wholly separated from the Kainozoic, and be made to constitute the uppermost member of the Mesozoic series of Periods.

The changes which M. Meyer now proposes are these:—I. For "Mayencien" he substitutes the designation "Langhien," from a chain of hills between Acqui and the upper course of the Tenaro; the change is made in deference to the dislike of the Germans to the word Mayencien,—a very insufficient reason. II. Mr. Tournouër's recent discovery, on the boundary of the Department of the Gers and the Landes, of beds identical with the Faluns of Touraine, proves that these last are not merely a facies of the Saucats beds, but belong to a higher level, stratigraphically distinct; as also by a fauna less rich in tropical species, richer in Mediterranean forms. This level being intimately connected, in the S.W. and central France as in the Swiss-German Jura, with that which follows *(the beds of* Serravalle), it becomes necessary to unite it to the

"Helvétien" stage. Mayencien ii. b. becomes Helvétian i.; Helvétien ii. and iii., H. i and ii., for all the localities quoted, except those of the hill of Turin, which remain at the level of the Manthelan beds (Rio della Batteria, Villa Roassenda, lower Baldisséro), or at that of the Serravalle beds (Termo-Foura, Pino, upper Baldisséro). The beds with large Lucinæ, of Pino, Stazzano, of Monte-Baranzone near Modena, are the Italian representatives of the Leitha limestone.

"The new stage which, in agreement with M. Séguenza, I propose to intercalate is in every respect most interesting. First it fulfils exactly, both by position and fauna, the middle place betwixt the Miocene and Pliocene which was wanted, to demonstrate the uselessness of such distinction. It presents at the same levels extended salt, brackish, and fresh-water deposits. Lastly, it connects together a number of deposits whose places had not been determined, such as the brackish water beds of the Danube basin, and the upper fresh-water Mollasse of Switzerland. It is to the middle stage that M. Heer gave the name of that of "Œningien;" it is to its lower level that the Sarmathian stage of M. Suess is to be referred; and it is for its thick marine beds of the neighbourhood of Messina that M. Séguenza would propose the name of the Zankléen stage. Separated from the Astien stage, such as I had at first proposed it, the Missinien stage comprises 3 levels.

"3. The Epplesheim beds, including the pebble beds of the Tortonias and of the Plaisantin. The sands and pebbles with Dinotherium of the valleys of the Danube, the Jura, and the Rhine, and the corresponding beds in the S.W. of France.

"2. The Dreissena (Congeria) beds of the Danube valley, and of Kertch, the region of the upper gypsum beds of the N. Apennines, the upper fresh-water Mollasse of Switzerland.

"1. And lowest, the Billowitz beds, those with Cerithia and Mactra Podolica of the Danube valley and Russia. The marls with Cerith. of Stazzano and St. Agate near Tortona. The white, sandy and micaceous Mollasse of the North of Switzerland.

"The Marine marls of Messina, their great thickness considered, are the probable equivalents of the whole of these three levels."

REPORTS AND PROCEEDINGS.

Geological Society of London.—I.—January 8, 1868.—1. "Notes on the Lower Lias of Bristol." By W. W. Stoddart, Esq., F.G.S.

Three sections in the suburbs of Bristol were described by the author, as exhibiting the following strata in descending order, namely, at Ashley Down, (1) *Ammonites-costatus* bed, (2) Saurian bed, (3) *Ammonites-Conybeari* bed (commencement of the zone of *A. Bucklandi*), and (4) Lima-beds; the succeeding beds are covered up for a short distance, and then, in Montpelier quarry, are exposed.

(5) *Ammonites-taurus* bed, (6) Echinoderm-beds, (7) *Ammonites-Johnstoni* beds, and (8) Avicula-bed; in Cotham quarry are seen (9) Rubble-bed, containing *Ammonites planorbis*, *Lima gigantea*, and *L. Dunravenensis*, (10) *Ammonites-tortilis* bed, (11) Sutton-beds, (12) *Pholidophorus* bed, (13) *Ammonites-Johnstoni* beds, (14) White Lias, and (15) Cotham marble resting upon the Keuper marls, the *Avicula-contorta* beds being absent. Mr. Stoddart considered that the Cotham section afforded very decided evidence of the Bridgend series being above the Rhætic beds, and in the Planorbis-zone. He also described an horizontal section of the deposits between Ashley Down and Cotham, and remarked on the physical conditions which had combined to produce the phenomena observed in the district.

2. "On the Lower Lias Beds occurring at Cotham, Bedminster, and Keynsham, near Bristol." By C. O. Groom-Napier, Esq., F.G.S.

The author described in detail sections exposed in two quarries at Cotham, and noticed others seen at Bedminster and Keynsham. He had made an extensive collection of fossils from the several beds, and he now exhibited a table showing the names and ranges of the several species. The conclusions at which he had arrived were that the Sutton-stone is a Liassic rather than a Rhætic bed, and belongs to the Planorbis-zone; and that the Planorbis-zone and the Sutton series are subdivisions of the White Lias. Mr. Groom-Napier also described two new species from the Planorbis-zone of Cotham, namely, *Avicula Sandersi* and *Anatina Cothamiensis;* and one—*Hinnites minutus*—found in a stratum at Cotham associated with *Monotis decussata.*

3. "On the Dentition of *Rhinoceros Etruscus*," Falc. By W. Boyd Dawkins, Esq., M.A., F.R.S.

The number of teeth possessed by *R. Etruscus* is the same as that of the species already described by the author.

The first premolar, if present at all, disappeared very early in life, leaving no trace of its existence. This character separates it from all other known Miocene species. Of the milk-molars the author has not yet sufficient materials to attempt a description.

The upper true molars differ from those of other British species in the lowness of their crowns, the abruptly tapering form of the colles, *d* and *e*, and the stoutness of the guard *o* on the anterior aspect. The grinding surface of the crown is deeply excavated, not worn flat as in *R. tichorhinus*. The horizontality of the guard *o*, and the height above the cingulum, characterize the whole of the premolars, and distinguish this species from all others found in Britain.

The lower true molars differ from those of *R. megarhinus* in being smaller, having the crowns lower, and the guard *o* more strongly marked. They differ from those of *R. leptorhinus* and *tichorhinus* in the position of the guard, the lowness of the crown, the thickness of the enamel, and the absence of costæ from the rounded anterior area.

R. Etruscus, together with all Miocene species (except those of the Sewalik Hills), belong to the brachydont section, while all the living *Pliocene* and Pleistocene species (except *Etruscus*) belong to the hypodont section. We have, therefore, to compare *R. Etruscus* with Miocene rather than with Pliocene and Pleistocene species. It differs from the Rhinoceros of Auvergne principally in the greater complexity of its *anterior valley* and the larger development of the *posterior combing-plate*. Its nearest ally is the hornless Rhinoceros of Darmstadt, the *Acerotherium incisivum* of Kaup.

R. Etruscus has been found associated with *R. megarhinus*, but not with *R. tichorhinus* nor *R. leptorhinus*.

It has not been found with any animal (except the Mammoth) fitted for living in a severe climate, nor in any deposit of post-glacial age.

II. January 22nd, 1868.—1. "On the Speeton Clay." By John W. Judd, Esq., F.G.S.

In tracing the history of discovery in connexion with this formation, the following epochs were pointed out by the author:—(1) the separation of the Cretaceous from the Kimmeridge beds, by Prof. Phillips, 1829; (2) the reference of the former to the Neocomian formation, by MM. Agassiz, Godwin-Austen, Römer, and others, 1838, etc.; and (3) the recognition of Portlandian beds in the series, by Mr. Leckenby, 1864.

Mr. Judd then proceeded to give a description of the *unique* cliff-section exposed at Speeton, which is unfortunately greatly complicated by faults and contortions, and much obscured by drift, landslips, and mining workings.

After adducing evidence, both stratigraphical and palæontological, to prove that no portion of the Speeton clay is of Gault age, the author showed that this great series of clays (probably over 1,000 feet thick) belongs to no less than seven formations, viz., Upper, Middle, and Lower Neocomian, Portlandian, and Upper, Middle, and Lower Kimmeridge. These formations, as displayed in Filey Bay, were described in detail; lists of the fossils from each (drawn up with the assistance of Mr. Etheridge) were given, and their equivalents, both in this country and on the continent, pointed out; and the author concluded his paper with appendices on the fossils and the economic products of the Speeton clay.

2. "Notice of the Hessle Drift as it appeared in Sections more than forty years since." By Professor John Phillips, D.C.L., F.R.S., F.G.S.

Referring first to the difficulties formerly experienced in attempting to explain the origin of the Boulder-clays and Northern drifts more than forty years ago, without the aid of glaciers and icebergs, the author expressed his belief that the lowest gravels, resting on the Chalk at Hessle, are of pre-glacial date. He stated his opinion that there is no evidence of the beds in question being marine; while the abundance of mammalian remains offers a strong presumption against this interpretation. Beds of this order, composed of chalk and flint fragments, are not only unknown in the midst of the Boulder-clay, but can hardly be imagined to exist there. Further, the Boulder-clay rests on them without conformity. Professor Phillips also observed that if the Hessle clay be the upper part of the great Holderness deposit, and not met with beyond the outcrop of the Chalk, it must be designated a third Boulder-clay; and he concluded his paper by a detailed description of his original observations of the Hessle cliff more than forty years ago.

GEOLOGICAL SOCIETY OF GLASGOW.—At the usual monthly meeting on Thursday evening, Dec. 12,—Dr. Young, president, in the chair,[1]

Mr. J. Thomson exhibited specimens of Carboniferous corals of the genera *Clisiophyllum*, *Cyclophyllum* Duncan and Thomson, and *Aulophyllum Edwardsi*, sp. nov., D. and T.; and entered into explanations of the structural characters upon which these forms were established

Mr. John Young made some remarks upon this so-called new genus of corals, *Cyclophyllum fungites*, and stated that since the time of David Ure (who was the original discover of the genus in question) this coral had been changed from one genus to another by Palæontologists, no less than two new genera having been established to receive it, and he doubted very much if it had yet found its final resting-place. He deprecated very much the establishing of generic distinctions upon small and unimportant points in any organism, as tending to burden science with useless synonyms. He further pointed out that Professor M'Coy had clearly delineated the various parts constituting the internal organization of this coral.

And in his remarks upon the genus *Aulophyllum* of Milne Edwards (of which Ure's coral was the type), M'Coy showed that the characters which he relied upon as points of generic distinction only serve to characterise a well-marked species. Dr. Duncan's figures reveal no new points in the structure of this coral which were not already known, and however much Dr. Duncan may differ from Professor M'Coy and other Palæontologists who have worked upon this genus, in his interpretation of the various points of structure therein displayed, yet he (Mr. Young) thought that these points were so small and unimportant as hardly to warrant it being again placed in a new genus.

Mr. Thomson, in replying to Mr. Young's remarks, drew attention to two errors of Ure's; first, that he described the corallum referred to by Mr. Young as being broad at the base, a feature presented by *Amplexus* only; second, that he gives Kilbride as the locality, whereas Mr. Thomson had not found in any of the Kilbride localities any other turbinated Coral than *Zaphrentis*. Mr. Thomson repeated the structural characters of *Clisiophyllum*, *Aulophyllum*, and *Cyclophyllum*, and insisted on the essential difference of the latter from the two former in this, that the endothecal structure of its columella is formed by a system of down-curved sub-convolute plates passing from the inner margin of the minute lamella of the essential columella; and that a groove was thus formed round the inner ends of the primary septa and the columella by the curvatures of those plates, and that the minute septa coalesced and formed a system of es which passed inwards and downwards, conforming to the ral concavity of the top of the columella.

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[1] The report of this meeting was unavoidably delayed.

I.—January the 9th, Prof. Young, President, in the chair, the etary read a letter from Mr. Robert Craig, of Beith, on the cial Drift in that district. He stated that it consisted of two ly distinguished beds, the lower composed of dark-blue clay, full olished stones of great size ; the upper of a light reddish friable , full of small stones, rounded and smoothed, but the polish had eather-worn appearance.

he Rev. Mr. Crosskey read some "Notes on the Discovery of *a arctica* at Stevenston, Ayrshire." This shell is so remarkable, ccount of its high northern habitat, that its discovery in any bed f peculiar importance. Living, it dwells only within the Arctic le and on the North-east Coast of America. It was identified by Torell among the shells found at Elie by the Rev. T. Brown, occurs in the clays at Errol and Montrose, on the east of Scot-l, but hitherto has not been found in any of the clay beds of the st. The specimen exhibited (kindly given to him by Mr. astrong) was found at Stevenston, Ayrshire, and is in a fine state preservation. Its occurrence in the West proves that the racter of our fauna has been as severely Arctic as the ancient a of the Eastern beds. *Leda arctica* is the characteristic shell he clay at Mess in the Christiana fjord, although not now found ng even in that locality. It is also a characteristic fossil in the icava-sand of Canada. The occurrence of *Leda arctica* in the old s of Canada, Christiana fjord, Errol, and Stevenston, affords a ious illustration of the wide distribution of very highly Arctic lusca during the glacial epoch. Mr. Crosskey also read a paper n the Characteristics of Boulder Clay." There are various lder clays, instead of one single deposit, which it is imperatively essary to distinguish from each other. The attention of geo-ical students was called to the necessity of discriminating between different kinds of materials which have been loosely united under general name "boulder-clay."

II.—Thursday evening, 16th January, E. A. Wünch, Esq., V.P., he chair.

dward Hull, Esq., F.R.S., of the Geological Survey of Scotland, ivered a lecture "On the physical causes which seem to have ulated the distribution of the calcareous and sedimentary strata of at Britain, with special reference to the carboniferous formation." Vhile admitting that calcareous matter was sometimes precipitated the sea-bed from chemical solution, the lecturer maintained that great masses of limestone are the result, either directly or indi-tly (by subsequent triturition and stratification) of vital agencies, ile the sedimentary strata were of mechanical origin. Hence the ntial distinction of the two classes in their origin. It was shown t the limestones of geologic periods were the work of a few ups of animals of an organization inferior to that of the molluscs, which only took a secondary position as the builders of these rocks. These animals included corals (*Anthozoa*), crinoids (*Echinodermata*), bryozoa, sponges (*Amorphozoa*), *Foraminifera*, and amongst these the *Diatomaceæ* also took an important position in eliminating the siliceous matter held in solution; but these were all animals which required clear water, free from sedimentary matter, in order to fulfil their functions.

Sedimentary strata on the other hand, being the detritus of land surfaces carried down and deposited by currents over the floor of the sea, could not co-exist in any quantity with the calcareous formations, but must have had a source at some region opposite to the centre of distribution of the limestones. Hence the conclusion was drawn—(1). That in any natural group of rocks the calcareous and sedimentary members must have had their sources in opposite centres of dispersion; and (2). That the maximum development of these two classes of strata must be at opposite points of a special region.

The "passage beds" and alternations of limestones with shales and grits, similar to those of the lower carboniferous series in the north of England, were accounted for on the ground of the alternate predominance of the vital and mechanical conditions of marine depositions over intermediate areas or border lands.

The tendency of geological groups to arrange themselves in a threefold order—the lowest and highest members being of sedimentary materials, and the central one calcareous—was then alluded to; and the lecturer proposed a classification of this kind for the whole of the geologic series, from the Lower Silurian to the Tertiary inclusive, and believing this to be a truly natural grouping, he accounted for it on the ground that each natural group was composed of the representatives of three periods—the 1st, one of movement, accompanied by change of land and sea and much denudation; 2nd, a period of comparative repose, and a minimum of denudation; and, 3rd, of change, gradually increasing in intensity to the close of the epoch.

The following is a brief outline of the classification as proposed by the lecturer:—

Tertiary Period.	3. Sedimentary—Miocene beds.
	2. Calcareous—Nummulite Limestone.
	1. Sedimentary—Lower Eocene beds.
Cretaceous.	3. Sed.—Uncertain.
	2. Cal.—Chalk.
	1. Sed.—Greensand and Gault.
Portland.	3. Sed.—Marine equivalents of the Purbeck and Wealden.
	2. Cal.—Limestone.
	1. Sed.—Sands.
Coralline Oolite.	3. Sed.—Calc. Grit and Kimmeridge Clay.
	2. Cal.—Coralline Oolite.
	1. Sed.—Calc. Grit.
Lower Jurassic.	3. Sed.—Oxford Clay.
	2. Cal.—Lower Oolite Limestones.
	1. Sed.—Lower, Middle, Upper Lias.

Trias.	3. Sed.—Red Marl.		
	2. Cal.—Muschelkalk (Germany).		
	1. Sed.—New Red Sandstone.		
Permian.	3. Sed.—Marls and Lr. Bunter Sandstone (Saxony).		
	2. Cal.—Magnesian Limestone.		
	1. Sed.—Conglomerates, Marls, and Sandstones (Rothe-todte-liegende).		
Carboniferous. England.	3. Sed.—Yoredale beds, Millstone Grit, Coal Measures.		
	2. Cal.—Limestone.		
	1. Sed.—Lower Shales, Yellow Sandstone (Ireland).		
Devonian		Devonshire.	Rhine.
	3. Sed.	Sandstones, Schists, etc.	Schists, Sandstones, etc.
	2. Cal.	Ilfracombe Limestone, etc.	Eifel Limestone.
	1. Sed.	Schists, Sandstones, etc.	Spirifer Sandstone Group.
Upper Silurian.	3. Sed.—Tilestones and Upper Ludlow beds.		
	2. Cal.—Aymestry and Wenlock series.		
	1. Sed.—May Hill Group.		

For the purposes of determining the directions in which the two classes of sedimentary and calcareous strata augmented and decreased in thickness, leading to a knowledge of the position on the globe of the continents and open seas of former geologic times, *Iso-metric* lines were proposed. These lines, drawn over the areas occupied by the formations, and each line representing a certain thickness of its special class (calcareous or sedimentary) of strata, would be found to lead to very interesting results. Mr. Hull had already drawn these lines for the Carboniferous group of Great Britain, and they are shown in the map published by the Geological Society of London (Quart. Journ., vol. xviii., p. 127); and he had no doubt that if similar lines were drawn for all formations in different countries, an amount of light would be thrown on the physical condition of the respective groups that would considerably advance this branch of science. The tracing of these lines had thrown much light on the physical geology of the Carboniferous group, showing that the calcareous member (mountain limestone) attained its maximum development in central England, and the sedimentary member in the North, leading to the inference that an old North Atlantic continent was the original source of the sedimentary materials.

The reason of the comparative thinness of the sedimentary strata of the Carboniferous series in Scotland, as compared with those in North Lancashire, was then explained, on the ground of the shallowness of the sea bed; the impediment to the transportation of materials presented by the Highlands (only partially submerged) and the incompleteness of the series. It had also been found that the sedimentary beds of the Triassic group, and of the succeeding Jurassic group of England, swell out towards the north; and the lecturer expressed his belief that originally all the limestones of this series tailed out or passed into sedimentary strata northwards, while the clays, shales, and sandstones of the same group attained the highest development in the same direction. This would lead to the conclusion that there had, throughout a long lapse of geologic time, been a general transportation of materials southward from old lands which once occupied the region of the North Atlantic.

CORRESPONDENCE.

BEACHLESS SEA-COASTS.

Dear Sir,—Though the true form of the ground can be best judged of by those who are in the habit of viewing it from greater or less distances, such minute observations as those stated by Mr. Green, in January last, are very important. It is, however, to be regretted that so accomplished a surveyor should not be empowered, by a committee of the British Association, to examine those sea-shores where level beaches are exceptional, and where the slope, above and below mean water-mark, is characterized by every form of escarpmental phenomena. On such shores, rising and falling lines of cliff may not only be observed at certain heights above the sea (where, in some instances, they might be called indirect sea-cliffs, being the effect of coast-slips), but likewise passing under, and from under, the water. Beachless shores are the general rule on the west and north coasts of Ireland, among the Shetland and Feroe Islands, etc. But, though on a smaller scale, they are very characteristic of the coasts of Devon and Cornwall, where, in many places, the base of a line of cliffs consists of a succession of heights and hollows. The minor deviations from a plane presented by many upland lines of cliff may thus be satisfactorily accounted for. To deny that the *general* inclination of an escarpment can be the effect of elevation is to ignore the established principle that the rise of the land must be in *excess* of the rise of the bottom of the sea. In bringing forward instances of escarpments, it is desirable that the meaning attached to the word should be clearly stated. If an escarpment runs along the strike it must maintain one level throughout, or a succession of different levels. If an escarpment follows the dip of the strata, it cannot run along the strike, and, unless the dip of the table-land above corresponds, no downwardly-operating agent could ever have commenced the work of escarpment-making. If an escarpment crosses the dip of the strata it must have been denuded irrespectively of structure. Wherever the dip of the strata (local or general) is as great as the dip of the escarpment, it is certain that the former must have been unequally upheaved or depressed, or thrown out of their originally horizontal position at *some* period, and why not after the formation of the escarpment, unless in instances where reasons to the contrary can be assigned? These considerations would seem to be overlooked by subaërialists, who thus render themselves liable to be misunderstood.

The Rev. O. Fisher's letter (p. 34, written before the appearance of my letter in the December Number) contains observations wonderfully agreeing with the views I have been advocating in your

pages. Col. Greenwood (whose description of the transportation of flints by the sea is very graphic) has misunderstood me on the subject of residual flints. What I meant was simply that in *many* chalk districts (not arable-fields) the denudation has been as clean, and as irrespective of flints, as if the ground had been shaved down with a gigantic scythe.
D. Mackintosh.

POLYTELITE IN CORNWALL.

Sir,—The substance of Mr. Davies's letter in your last number does not, I imagine, require any reply; but in the postscript he mentions that Professor Church had found $7{\cdot}23\,^0|_0$ Silver in a crystallized fragment of fahlerz, having the density of 4·85, from which I infer that true polytelite is found at that locality. This per centage of silver in, and the specific gravity of, this specimen, might be accounted for by supposing the silver in other state of combination, as, for example, argentiferous sulphide of silver (Stromeyerite), which in fracture closely resembles some fahlerz; and therefore it would be interesting to know from Professor Church whether the other constituents of polytelite (antimony, for example) were found, which would at once decide the question.

Mr. Davies does good service to British mineralogy by directing attention to any cases of unrecorded mineral localities; and I believe such inquiries will prove that we possess many more mineral species in Great Britain than are at present recorded. Amongst others, I may mention that polytelite from N. Wales, and Gersdorffite from Argyleshire, are described in the second part of my "Researches in British Mineralogy," now in the press.
David Forbes.

THE BOULDER CLAY AT WITHAM STATION, AND THE THAMES VALLEY.

Sir,—My last letter was accidentally printed without my correction, and contains errors, two of which are of some importance.

In the section, the sand with green-coated flints should be "Thanet" instead of "Thames" sand.

My views regarding the age of the "Trail" are singularly misrepresented, where I am made to say it is of "our" age. I wrote "one" age; which I believe to have been upwards of 110,000 years ago, as I have shown in the fourth volume of your Magazine, p. 197.

Harlton, Cambridge.
O. Fisher.

THE OUSE VALLEY, THE THAMES VALLEY, etc., etc.

Sir,—I find that at pages 53–57 of the memoir for sheet 45, reference is made to the Glacial clay, but so slightly that it escaped me. Moreover the Glacial clay tract north of Buckingham, partly traversed by the section in my last letter, is alluded to (p. 57) as that of the "Oxford or Kimmeridge, as the case may be"; but as neither of those clays are shown in this part of the map, some slip of the pen may have occurred. Therefore, to this extent, I must qualify the remark in my letter and tender Mr. Green my apology for it.

The accuracy and bearing of our respective sections I leave to the judgment of others.

From Mr. Green's view, that the Glacial and Post-glacial beds cannot be represented on the inch scale without detriment to the delineation of the older geology, I strongly dissent, so far as concerns the secondary and tertiary area, south of Flamborough Head; and I have done my best, in sheets 1 and 2, to show that all beds may be represented together without detriment to any; and I contend that it is beyond human ability to represent, with any approach to accuracy, the geological features of such part of that area as is occupied by the Glacial beds in force, except those beds be mapped in with the older formations. North of Flamborough Head it is otherwise. I have examined railways in course of formation in Northamptonshire and Huntingdonshire, through districts in which the hills and valleys appear from the survey maps to be cut out of the secondaries, and in one instance out of a succession of secondary strata; but the cuttings have disclosed that the hills traversed by them are wholly formed of the Glacial beds, nothing of the map delineation being visible.

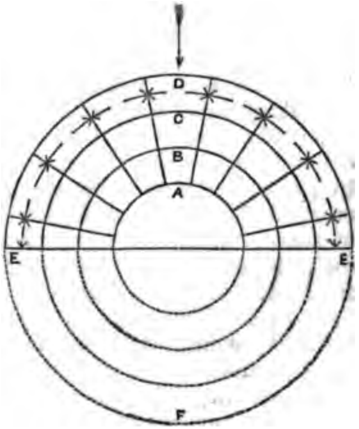
Mr. Fisher has correctly represented my views as to the cappings termed Trail; and I quite agree with him that the Clacton and Grays deposits are of similar age, having so expressed myself at page 350 of your third volume. The other points in his letter would take up too much of your space to discuss; but, if the information he obtained from the Witham boring be truly reliable, it seems to point to a great local disturbance and denudation of the four or five miles from Kelvedon to Witham, either between the Middle and Upper Glacial formations, or during the earlier part of the Upper; and I suspect that in such case my sections, No. 9 of page 348 of your third volume, and No. 9 of page 402 of the twenty-third volume of the Quart. Journ. of the Geol. Soc.; may prove to contain an error in so far as they show the Middle Glacial dipping with a fold under the Upper, where they cross the Blackwater. There is, I think, evidence, from clear sections, of such an intermediate disturbance and denudation near Ipswich, the effect of which has been to bring the Glacial clay into the bottom of the Gipping valley for three or four miles without any Middle Glacial under it; while the Middle and Upper Glacial beds form the whole country around, the valleys being entirely cut out of them. The Gipping valley, except where this anomalous structure occurs, forms no exception to the general features presented by these valleys, and the case of the Blackwater seems much the same. I am very glad, although I dissent from the gravels over the Hampshire Tertiaries being the equivalent of the Glacial clay, to see Mr. Fisher disposed to regard the Glacial sea as having extended over the South of England prior to the great upheavals and denudation of that part, and to connect the dislocations in the Thames valley with those movements; these being the most important links in the chain of events which I contend have followed the Glacial period.

S. V. Wood, Jun.

GRAVITATION, COMPRESSION, AND SLATY CLEAVAGE.

SIR,—Dr. Sterry Hunt, in his paper in the February Number of the MAGAZINE, referring to the alleged condensing power of the superincumbent mass on the central parts of the earth, remarks: "The condensing effect of pressure was by Dr. Young estimated to be sufficient to reduce a mass of granite at the earth's centre to the eighth of its bulk at the surface, which would give the earth a mean density equal to twelve or thirteen times that of water: this consideration has led a recent writer in the London *Athenæum* to conclude with Herbert Spencer that our earth and the other planets may be only shells of varying thickness, enclosing a central cavity filled with vaporous matter, by which hypothesis we may explain their comparatively feeble densities." Mr. David Forbes has also noticed that the average density of the earth falls short of what it would be, supposing it grew denser in descending, in proportion to the superincumbent pressure; and "That experimental research tends to show that a limit is soon reached beyond which the compression or increase of density becomes less and less in proportion to the force employed."

Do not the estimates of hypothetical increased central density fail to consider the influence which the spherical form of the earth would have in counteracting accumulating pressure, and diverting the force of gravitation to a direction parallel with the circumference?



The case seems strictly analogous to that of an arch, in which the resulting force of gravitation is diverted along the arch to the abutments. If the earth is hypothetically assumed to be made up of a series of concentric hollow spheres (see Woodcut) A, B, C, D, it will be at once evident that each of such spheres would be self-supporting, just as in the case of a bridge, the addition of each successive course of brickwork composing the arch adds no pressure to, but rather increases, the resisting power of the single course first laid; the direction of the resistance of the gravitation of the mass being accumulated on the spring of the arch. Again, if we go on filling up this arch internally with successive courses of brickwork, we do not interfere with the stability of the external arch, neither is the weight of the first structure borne by the inner courses; in fact every zone of the arch or sphere is individually self-supporting. The *vertical* pressure of gravitation, which in successive superimposed layers of a plane would *accumulate*, is vertically neutralized in a sphere, and instead of getting the *sum* of the weight of the concentric layers, the independent pressure of each successive course is diverted in a line parallel with the circumference. To carry out the analogy we have merely to suppose two such semicircular arches, E F E and E D E, placed base to base in contact; the balance of resistance is completed, and we get a perfect epitome of the equilibrium of gravitation in the crust of the earth. Will not this satisfactorily explain the point noticed by Mr. Forbes, that the actual density of the earth falls short of its calculated density, on the estimate of the *accumulation* of superincumbent pressure? and will not the lateral pressure, analogous to that existing between the voussoirs of an arch, account for the horizontal force which seems to have operated in the production of Slaty Cleavage?

George Maw.

Benthall Hall, Broseley,
Feb. 10*th*, 1868.

I.—THE GRAPTOLITES OF THE SKIDDAW SERIES, ETC.

II.—ON THE CLASSIFICATION OF GRAPTOLITES.

Sir,—1. In the Geological Magazine for January (p. 32), an abstract is given of my paper on the Graptolites of the Skiddaw Series, read before the Geological Society, December 4th, 1867.

As the generic characters of *Dichograpsus* are therein mis-stated, I should be glad if you will allow me to correct the error,[1] since I observe that it has been reproduced in a recent paper on Graptolites.

The presence of a corneous cup does *not* form a character of the genus *Dichograpsus,* since it is present in some species of the genus, and is uniformly absent in others. It likewise occurs in some *Tetragrapsi,* whilst it is never found in others, as *T. bryonoides,* Hall, and *T. quadri-brachiatus,* Hall. Lastly, it is occasionally found in some *Diplograpsi,* as *D. bicornis,* Hall. As the remainder of the definition of the genus is also incorrectly stated, I may be permitted to add that *Dichograpsus* is sufficiently defined by "the possession of a frond composed of a variable number (always more than four) of simple stipes, arising from a central non-celluliferous stem or funicle. The stipes are monoprionidian, and are given off from the funicle in a radiating manner."

II.—As a recent paper of mine on Graptolites (Ann. and Mag. Nat. Hist. Jan. 1868) has formed the subject of a somewhat lengthy criticism by Mr. W. Carruthers, in the Geological Magazine for February, (p. 64), I trust you will afford me space for a reply. For the sake of brevity as well as clearness, I will notice such points as I may think necessary, in the order in which they occur in Mr. Carruthers' paper, premising that I have no intention of criticising, and shall simply touch upon such points as concern me personally.

1. Mr. Carruthers finds fault with me for "summarily" dismissing the Polyzoa, and for asserting that they "have, as a rule, a more or less calcareous test, and the individuals forming the compound organism are not united by any organized connecting substance."

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[1] The abstract here referred to, is furnished by the Assistant Secretary of the Geological Society, and is merely reproduced in the Geological Magazine.—Edit.

In answer I have simply to state, that my paper was *intended* to be simply an abstract, and "summary" of a more detailed one, which I trust may one day see the light, and that it was, therefore, impossible for me to enter into minutiæ. Secondly, though perfectly aware of this existence of free and corneous Polyzoa (the Ctenostomata of Busk), the above statement nevertheless remains true of the Polyzoa, "*as a rule*," and I see no reason for altering it.

2. Mr. Carruthers charges me with adopting a statement of Hall's, as to the free mode of existence of Graptolites, without acknowlegement. To this it is quite enough to reply, that the statement in question was not made as an original observation on my part, and that it is impossible in a general paper to quote references for all the facts which have been previously noticed. As to my making a "practice" of so doing, no denial on my part can be needed. My published papers on the subject bear ample witness how much I am indebted for real solid information to the writings of Hall, Salter, Harkness, Barrande, and Geinitz. The changes in my views, to which Mr. Carruthers refers, have been the result of the progress of my own researches, and I could not, with honesty, attribute them to any "corrections" from Mr. Carruthers.

3. As for my use of the word "gonophore," instead of "gonotheca," to signify the external bell-shaped ovarian capsule of the Sertularidæ, it will suffice to make the following quotation from Prof. Greene, whom, I suppose, Mr. Carruthers will allow to be somewhat of an authority upon the Hydrozoa. "In the Sertularidæ .... the reproductive bodies appear externally as distinct buds or sacs, for which Prof. Allman has proposed the name of 'gonophores'" (see Coelenterata, p. 40). This is but one of many similar statements in the same work, but it will, I imagine, be sufficient to justify my employment of the term.

4. With relation to the genus Pleurograpsus, the facts of the case are simply these. In 1852 Geinitz proposed the name Cladograpsus to include certain Graptolites (species Gemellæ, Bronn.), comprising Diplograpsus ramosus, Hall, and several species of Didymograpsus. In 1859, seven years afterwards, Mr. Carruthers applied the same name to a very peculiar branching Graptolite from Dumfriesshire, without giving any generic characters of any kind, an omission which he failed subsequently to rectify. The same Graptolite was described by me in March, 1867, in a paper read before the Geological Society of Edinburgh, in which I described it as the type of a new genus, giving a full diagnosis, and terming it Pleurograpsus. (See also GEOL. MAG. Vol. IV. No. 6, June, 1867.) In June of the same year, Mr. Carruthers re-described the species as a Cladograpsus, this time assigning characters to it as a new genus. As, however, these characters are totally different from those of the original genus of Geinitz, and as I was the first to give any generic description, the name Pleurograpsus must obviously be retained.

Finally, to the personalities with which Mr. Carruthers has seen fit to adorn his paper I shall return no reply, considering them unworthy of any genuine scientific controversy. I shall content myself with quoting the following passage, from a letter by Mr. D. Forbes in the last number of your Magazine, the sentiments of which I heartily endorse.

> "No man in Europe can expect to retain any portion of the field of science exclusively for himself, or to travel alone on any of the many different roads which lead to one and the same scientific truth. If real progress is to be made in science, the student must reason for himself, and not be content with accepting, merely on authority, opinions which are inconsistent with his own deductions and experiments; nor should he be deterred by the opposition to be expected from those already in office or authority, who are sure to be jealous of intruders on what they imagine to be their own domain, and, doubtless, dislike having their peace of mind disturbed by innovations."

HENRY ALLEYNE NICHOLSON.

QUEEN STREET, KEIGHLEY, *February 10th*, 1868.

GEOLOGICAL SURVEY OF BOHEMIA.

SIR,—I send you a short extract from the Report of our Geological Surveyors in Bohemia. A reference to the map shows that these labours have been very little disturbed by the late war.

The Orographical section (Prof. Koristka) completed, in the year 1865–6, 5,000 trigonometrical measures over a surface of 123 German square miles.

The Geological section (Prof. Krejci) have continued the examination of the Chalk formation, which will be very valuable when the large collection of fossils made by me shall be determined.

During the past three years I have placed 3,536 chalk fossils from 65 different localities in the Museum. One locality alone, called Korycan, has supplied 70 species.

The most important discoveries consist in (1) the finding of freshwater shells in the Upper Greensand, and (2) of a large deposit of Radiolites, near the city of Kuttenberg, where a celebrated Gothic Church is entirely built of these curious shells.

In 1867, 1,500 chalk fossils have been added to the Museum from 17 localities.

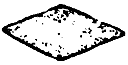
A new locality for *Eozoön* has been met with in the Gneiss, near Skuc, in S.E. Bohemia.

And, lastly, we have discovered reindeers' horns in the diluvial Loëss, near Prague. MED. DR. ANTON FRITSCH.

ROYAL BOHEMIAN MUSEUM, PRAGUE, 26th Dec., 1867.

MISCELLANEOUS.

AWARD OF THE WOLLASTON GOLD MEDAL AND DONATION-FUND.—At the Anniversary meeting of the Geological Society held Feb. 21, 1868, the President announced the Award of the Wollaston Gold Medal to DR. CARL FRIEDRICH NAUMANN, Foreign Member of the Geological Society, Professor of Geology and Mineralogy in the University of Leipzig, etc., in recognition of his labours, extending over nearly half a century, in the departments of Geology, Mineralogy, Crystallography, etc. The President also stated that the Balance of the Proceeds of the Wollaston Donation-fund had been awarded to MONS. J. BOSQUET, of Maestricht, in aid of the valuable researches on the Tertiary and Cretaceous Mollusca, Ento*mostraca, and* other fossils, of Holland and Belgium, on which he sab *been so long* and successfully engaged.



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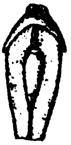

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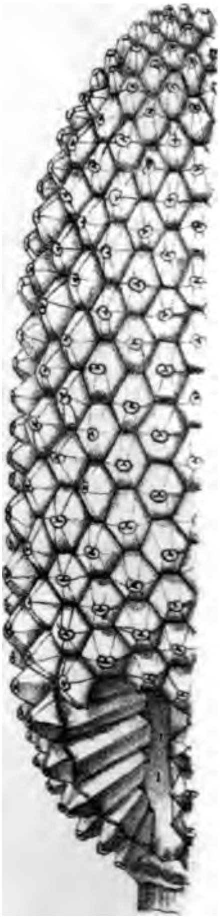

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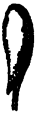

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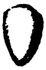

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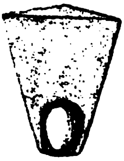

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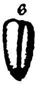

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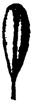

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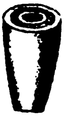

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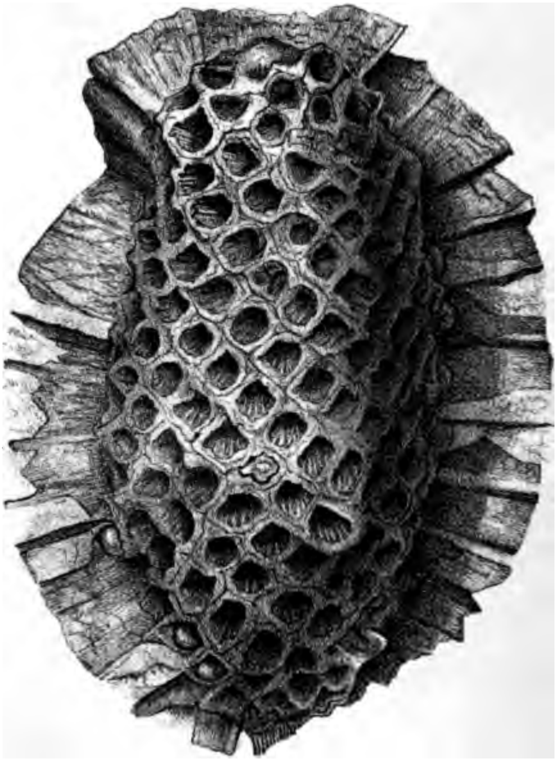

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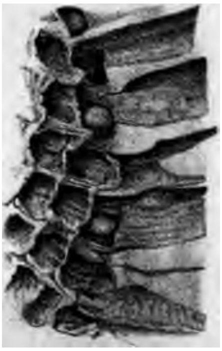

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THE
GEOLOGICAL MAGAZINE.

No. XLVI.—APRIL, 1868.

ORIGINAL ARTICLES.

I.—BRITISH FOSSIL PANDANEÆ.

By WM. CARRUTHERS, F.L.S., F.G.S., Botanical Department, British Museum.

(PLATE IX.)

THERE is room for considerable difference of opinion as to the limit of the order *Pandaneæ* or "Screw-pines." However extended it is made there can be no doubt that *Nipa* has closer affinities with the palms than with the screw-pines. I shall therefore exclude the remarkable fruits from the Lower Eocene of Sheppy to which Brongniart applied the name *Pandanocarpum*, altered afterwards by Bowerbank in accordance with the more precise determination of the affinities of the fruits to *Nipadites*, a change in which Brongniart acquiesced.

More nearly allied to *Pandaneæ* are the *Cyclantheæ* with their scaly flowers, polyspermous, many-celled fruits, and fan-shaped leaves, and the *Freycinetieæ* agreeing with *Cyclantheæ* in the structure of their fruit, but with *Pandaneæ* proper in their flowers and foliage. Whether these three closely allied groups form only a single natural order is not of much importance in connection with an enquiry into the fossil *Pandaneæ* of the British rocks, inasmuch as these all, as far as known, belong to the restricted group *Pandaneæ*, represented by the genus *Pandanus* of the younger Linnæus, now split up by Gaudichaud, De Vriese, and Hasskarl, into several divisions considered by them of generic value.

The recent *Pandaneæ*, thus restricted, are arborescent plants, the stem generally branching dichotomously and sending down aerial roots, with long, linear-lanceolate leaves, their margins almost always spiny, and their bases amplexicaul, leaving after decay annular scars, which have suggested the name screw-pine, the latter half of the term referring to the external resemblance of the plants to *Bromeliaceæ* or pine-apples. The flowers are diœcious and naked, and the fruits are composed of numerous one-celled and one-seeded fibrous drupes congregated singly or in compact parcels into large spheroidal or oblong heads. The plants of this group live in the marshy forests of the moist tropical and sub-tropical regions of the old world, their head-quarters being in the Malayan Archipelago, and in Madagascar; some extend as far north as Japan and the Himalayas.

Specimens of foliage referred by Ettingshausen to this order, although described originally by him under the name *Palæobromelia* have been found in the Tertiary deposits of Austria (Sitzungsber. d. Math.-Nat. classe der K. Akad. der Wissen. Vienna, vol. viii. p. 492). He considers that he has fragments representing five species, which he refers to the genus *Pandanus*.

In England the discovery of fruits has supplied more satisfactory evidence of the former existence of the *Pandaneæ*.[1] The first known specimens of a Pandanaceous fruit were figured and described by Prof. Lindley in the second volume of his Fossil Flora (1835), plate 129, under the name of *Strobilites Bucklandi*. Lindley, with great success, educes from his imperfect materials characters which would have led him to place the fossils in *Pandaneæ*, had he been obliged to give them a positive position, but he preferred referring them to the provisional genus *Strobilites*, until additional specimens should supply the materials for a more satisfactory determination. Lindley mentions neither the locality nor the age of these fossils, but only that they belonged to Miss Bennet, whose collections, I believe, are now in America. Professor Morris, in his Catalogue of British Fossils, says they were found in the Upper Greensand of Wiltshire.

In 1836 Buckland figured and described a fruit to which, at R. Brown's suggestion, he gave the name *Podocarya*. The fossil was found in the inferior Oolite, at Charmouth, Dorsetshire. It is the size of a large orange, and composed of an indefinite number of cells, each containing, near the surface, a single longish seed, about the size of a grain of rice. The cells were separated from the spadix by long fibrous footstalks, and were surmounted by hexagonal tubercles, in the centre of which could be seen the remains of a stigma. It is to be regretted that Brown did not communicate to Buckland a written description of this hitherto unique fossil fruit, for a looseness of language and defects in knowledge are to be found in the account of the fossil which cannot be charged to him. It is said that "the collection of the seeds into drupes, surrounded by a hard nut, in the fruit of *Pandanus*, forms the essential difference between this genus and *Podocarya*." But the fruits of a large number of species of *Pandanus* consist of separate one-seeded drupes, and if each seed in *Podocarya* be considered as contained in a distinct drupe, there is no essential difference between these species and the fossil. I am inclined, however, to consider it rather as a more complete condition of the union of the ovaries into groups than any form among recent fruits—a condition in which all the drupes were as thoroughly united as they are in each of the phalanges of the fruit of *Eydouxia macrocarpa*, Gaud. In the species with such compound fruits, the fibrous pedicles are much longer than in the other species, forming another point of correspondence with the fossil.

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[1] The external markings of the stems found by Mr. W. H. Bensted in the Iguanodon quarry, and named by König *Dracæna Benstedii*, are more like those of a *Pandanus* than a *Dracæna*, but the remains of wood in the interior of these stems suggest doubts as to whether they belong to either the one or the other. I hope to obtain a section of one of the stems and to examine the minute structure of the wood, and I may then be able to determine, with more certainty, their systematic position.

This singular fruit has been lost. Buckland says it was in 1836 in the Oxford Museum, but Professor Philipps has never seen it. Its re-discovery would be a real benefit to science.

Through the kindness of S. Sharp, Esq., F.G.S., I have been able to examine a remarkably perfect specimen of a fruit belonging to the same genus as those described by Lindley, and supplying the material which he desiderated in order to refer his fossils to their positive position. This specimen was found in the Moulton Park Quarries, at Kingsthorpe, near Northampton, in the White Limestone of the Great Oolite. It was presented by A. Markham, Esq., to the Northampton Museum, where it is now deposited. The matrix in which it is preserved is an amorphous cream-coloured limestone which has abounded in molluscan remains, but the shells have been removed, and the spaces they occupied, as well as the other larger cavities in the rock, are lined with or entirely filled up by crystallized calcite. The fruit also is only a cast, in the same material, of the cavity which originally contained it. The fine white mud had insinuated itself into every crack and opening of the fruit, and filled the decayed interior of the upper portion of the drupes. The walls of the seed cavity and the seeds themselves, as well as the outer membrane of the drupes, resisted decay until the matrix was somewhat compacted. These hard portions at length decayed, but the insoluble carbon remained as a black amorphous substance, giving an external coloured coating to the crystallized carbonate of lime, which in the end filled the cavity, preserving in the most perfect manner the form of the fruit, and even some of the minute details as to the relation of the different parts. The hammer of the quarryman that accidentally laid open the fruit has fractured it through the middle of the cells, the portion broken off containing the upper portions of the cells and the apices of the drupes buried in the rock.

The fruit consists of a thick spadix,—not so thick, however, in proportion to the drupes as in *Bryantia butyrophora*, Webb. The drupes leave the spadix at a right angle about one-third from the apex, those above have an ascending and those below a descending direction, increasing as it reaches the fruit stalk, which is seen in the fossil, and shown in the drawing. This arrangement is precisely that of *Sussea conoidea*, Gaud. (Pl. IX. Fig. 7). The drupes are rhomboidal at the base, spreading out laterally towards the apex, where their form is a broad compressed rhomb (Fig. 4) two or three times longer than it is broad. The cell containing the seed is near the base of the fruit (Fig. 3) leaving only a short pedicle or being really sessile, as in the recent species with single-seeded drupes (Fig. 7). Each drupe contains a single seed; and although, as I have said, the whole structure is replaced by calcite, yet the details are so beautifully shown that the connection of the seed by an internal unilateral placenta adnate to the whole length of the cell is in many cases obvious (Fig. 6). The seed is ovoid and compressed (Figs. 5 and 6), and the cicatrix at its base, by which it was attached to the placenta, can be detected.

The comparison of the drawings of *Sussea conoidea*, Gaud., taken from Gaudichaud's Voyage sur la Bonite, plate 24, given on Plate IX. Figs. 7–11, with the figures of the fossil and the description I have given, must place it beyond doubt that this is a true *Pandanaceous* fruit. I propose to designate the genus by the name of *Kaidacarpum*, Kaida being the Malabar name which Rheede employed in his Hortus Malabaricus, from which book the younger Linnæus chiefly obtained the materials for his genus, although he adopted the later name, *Pandanus*, from Rumphius.

Besides the species which I have described, I have seen another in the Woodwardian Museum, Cambridge, from the Potton Sands, which, from its imperfect condition, it would have been impossible to have made anything of, but there is sufficient to establish that it belongs to this genus, and is a distinct species.

SYNOPSIS OF THE BRITISH PANDANEÆ.

GEN. I.—KAIDACARPUM, gen. nov. Fruit composed of pyramidal rhomboidal single-seeded drupes, sessile, or sub-sessile on a thickened spadix.

Sp. 1. *K. ooliticum*, sp. nov. From the Great Oolite at Kingsthorpe. Plate IX. Figs. 1—6.

Sp. 2. *K. Bucklandi*, Carr. *Strobilites Bucklandi*, Lindl. and Hutt. Fossil Flora, Plate 129. From the Upper Greensand, Wiltshire.

Sp. 3. *K. minus*, sp. nov. From the Potton Sands, Cambridgeshire.

GEN. II. PODOCARYA, Buckl. Fruit composed of an indefinite number of single-seeded cells united into one large compact spheroidal head, and attached to the spadix by long fibrous pedicles.

Sp. 1. *Podocarya Bucklandi*, Ung., Gen. et Species Plant. Fossillium, p. 327. Buckland, Geology and Mineralogy, Pl. 63. From the Inferior Oolite of Charmouth, Dorsetshire.

EXPLANATION OF PLATE IX.

Fig. 1. *Kaidacarpum ooliticum*. Nat. size, showing the bases of the cells from which the seeds have fallen out. The upper portions of the drupes are seen imbedded in the rock around the fruit.—Fig. 2. A portion from the side of the fruit, showing the relation of the seeds to the drupe.—Fig. 3. Ideal section of a drupe and seed.—Fig. 4. The form of the apex of a single drupe.—Fig. 5. Front view of seed.—Fig. 6. Side view, showing where the placenta touched the seed. Fig. 7. *Sussea conoidea*, Gaud. Half of a fruit.—Fig. 8. Longitudinal section of a single drupe.—Fig. 9. Transverse section of ditto.—Fig. 10. Seed, front view.—Fig. 11. Ditto, side view.

II.—ON BANDED AND BRECCIATED CONCRETIONS.

By JOHN RUSKIN, ESQ., F.G.S.

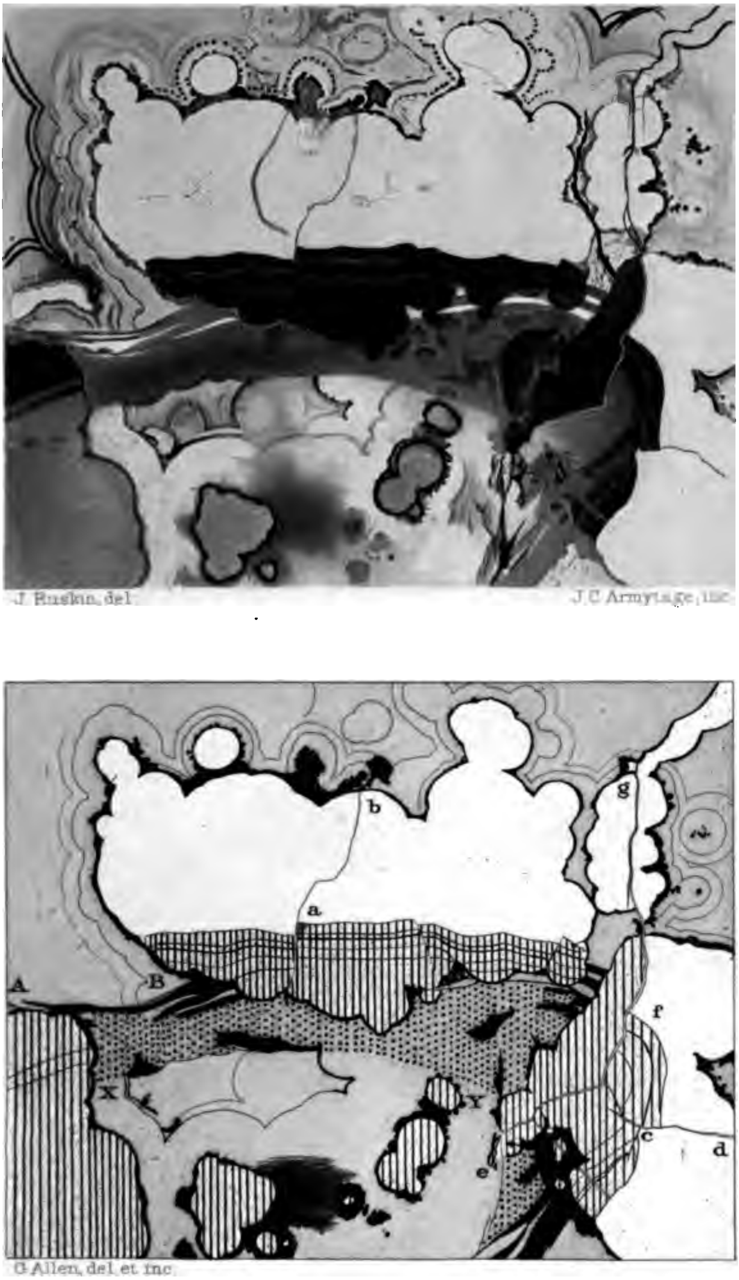
(CONTINUED FROM THE JANUARY NUMBER, P. 18).

(PLATE X.)

I PROPOSE now to pursue my subject by describing in some detail a series of typical examples of the principal groups of agatescent minerals; noting, as we proceed, the circumstances in each which appear to afford proper ground for future general classification.

The upper figure in Plate X. represents, of its real size, the surface of a piece of jasperine agate in my own collection, belonging to the same general group as the specimen, *a*, *b*, *d*, 5, in the British Museum. This group consists, broadly, of irregular concretions of jasper affected by faults caused by contraction, having their interstices filled with

Geol: Mag: 1868. *Vol. V. Pl. X*


J. Ruskin, del. J. C. Armytage, inc.

G. Allen, del. et inc.

SECTION AND MAP OF A CONCRETE AGATE.

chalcedony, and the whole enclosed by a quartzose crystalline mantle or crust.

The British Museum specimen (*a*, *b*, *d*, 5) is said to be Icelandic. Two others of the group are labelled "Oberstein;" one, of parallel construction, but slightly varied in character, is from Zweibrucken, in Bavaria. I do not know the locality of my own, but there is a community of feature in all the specimens, which assuredly indicates similarity of circumstance in their localities; and the more various the localities, the more interesting it will be eventually to determine their points of resemblance. I have not yet obtained an example of this group in the gangue, but the crust of the stones themselves is in every case composed of quartz-crystals rudely formed, sometimes so minute as to look like a crumbling sandstone: in my own specimen they can only be seen with a lens, associated in filiform concretions like moss; within this crust two distinct formations have first taken place, and then a change of state is traceable affecting both in new directions. The map-diagram, Pl. X. Fig. 2, is lettered, so as to permit accurate indication of the parts.[1]

The outer formation, next the crust, is composed of very pale whitish brown jasper. It is expressed by a shade of grey in the map, and is limited towards the interior of the stone by the strong line (with occasional projecting knots) thrown into curves, convex outwards.

The inner formation is of a finer jasper, with dark chalcedony in segregation. The vertical lines in the map indicate the chalcedony, and the pure white space, the inner jasper, terminated outwardly by convex curves. We are thus led at once to note the distinction between the two families of agates, formed from within outwards in knots, and from without inwards in nests. The first group, to which our present example belongs, is usually agatescent in the interior, and crystallized on the surface; the second is agatescent in the coating, and crystallized in the interior.

Supposing the silica deposited under the same circumstances of solution, and the same time granted for solidification, the difference between these two structures would depend (and often does depend) only on the chance of the silica finding a hollow prepared for its reception, or a solid nucleus round which it can congeal; the ordinary deposits on the inner surface of a nest often become nodular or stalactitic as they project into its open space, and the greater part of the apparently independent concretions are probably mere fragments out of the hollows of larger ones. But there is, nevertheless, frequently a true distinction between the two modes of deposit. The agates formed on a central nucleus appear usually to have had a longer time for their construction than those which fill hollows, or, at least, they are the portion of the mass, in the hollow itself, which has crystallized most slowly; they are distinctly reniform in their chalcedony, and distinctly symmetrical in their crystals;

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[1] I have carelessly worded the title of Plate X. as if the two figures were a vertical section and surface map; but the lower one is, of course, only explanatory of the upper.

while the nested agates run into level or irregularly continuous bands, and choke their cavities with confused net-work of quartz. I have difficulty in finding convenient names for these two families of agate; but merely for reference to them in these papers, I shall call those formed in knots, which are often conspicuously radiant in the lines of their crystals, "stellar" agates; and those evidently formed in cavities, "nested" agates.

I believe that the stellar forms, when independent, will be found most frequently under circumstances admitting the possibility of slow concretion at comparatively low temperatures, while the nested or bomb-like structure belongs characteristically to volcanic formations, in which the cavities might be filled by comparatively violent infusion, and their contents in many cases quickly cooled. Both conditions, of course, sometimes agree in all their processes; and we shall be able finally to classify these processes of deposit under description which will apply equally to the stellar and nested forms, marking afterwards the points of exceptional difference. Thus, for instance, the most frequent of all the forms of tranquil deposit, uninterrupted by flowing additions of material, is that in which a clear band of chalcedony, perfectly equal in breadth throughout, is first formed round the point (or branch) of nucleus, in stellar, or on the outer wall of the cavity in nested, agate. But after this has been formed in stellar agate, the succeeding belts will not usually show a minor pisolitic structure, whereas, in nested agates, marvellous groups of pisolitic hemispherical arches often rise from the inner surface of the clear external chalcedony, in section, like long bridges crossing a flat, and modify the whole series of bands above them; but, again, with this most important distinction between these and the bands of stellar agate,—that stellar bands, the farther they retire from the nucleus, usually throw themselves with increasing precision into circular curves, till they sometimes terminate in perfect and exquisitely drawn segments of spheres; while in nested agate, the bands, if parallel, efface more and more the original minor curves as they approach the centre of the nest, and sweep over them in broad indeterminate lines, as successive coats of paint of equal thickness efface the projections and roughnesses of the surface they cover, or as successive falls of snow, undrifted, efface irregularities of ground. And now, observe, we shall want a word expressive of an intermediate condition between the states above defined as pisolitic and reniform. A pisolitic mineral we define to be one which separates into more or less spherical layers by contraction; and this kind of division takes place sometimes quite irrespectively of the crystalline structure, and on the grandest, as well as the most minute scale. In one of my specimens of Indian Sard, there are multitudinous pisolitic flaws, exquisitely perfect in spherical curvature, dividing the parallel bands of the agate transversely in every direction, looking like little paleæ of chaff in its clear substance; on a large scale, the aiguilles of Chamouni are pisolitic, rending themselves into curved layers five or six hundred feet in the sweep of their arcs, variously crossing their cleavage (which is rectilinear), and often diametrically crossing their beds. On the other hand, true reniform structure is perfectly compact, and dependent on minute radiating crystallization of substance. But between the two there is the fine agatescent structure, in which bands of different materials, jasperine and chalcedonic, are separated from each other under a radiating law; and yet not divided by a mechanical contraction; for though they are often so distinct as to separate under the hammer stroke, they never leave spaces between, as true pisolitic beds do in ultimate separation. For this intermediate action, the most frequent of all, I shall keep the term "spheric;" and I was forced to admit only a guarded use of the word "gravity" in last paper, because this spheric action is constant, as far as I know, in all agatescent matter, so that I have never yet seen an instance in level-laid agate of the transition from the lake in the (lowest?) part of the cavity to the beds at the sides being made under any subjection to the mechanical law of gravity on fluent substance; but (as in the petrifaction of the banks of Dante's Phlegethon lo fondo suo, e *ambo le pendici*, fatt 'eran pietra, e i margini dal lato, "its bottom, and both the slopes of its sides, and the margins at the sides, were petrified"), the flinty bands form in parallelism on the slopes as well as the bottom, and retain this parallelism undisturbed round the walls and vault of the agate. On the other hand, I cannot but admit the idea that these rectilinear tracts are formed under a modified influence of gravity, because, first, I have never seen them laid in different directions in different parts of the same stone; and, secondly, whenever they are associated with pendent stalactites, they are at right angles to them. So that the aspect of one of these levelled agates in cavities may be approximately described as that of a polygonal crystal in which the position of one of its sides is determined by gravity; and the other sides modified into curves by radiating crystallization (of course the changes of form caused by gradual entrance or exit of material being at present withdrawn from consideration). In the example before us, which, though showing but feeble crystalline energy, belongs to the stellate group, the outer formation of rudely spheric white jasper withdraws itself confusedly from the sandy crust of quartz and becomes finer and finer towards the inner jasper, on the surface of which it throws down a coating of superb crimson (oxide of iron?) which is itself arranged every here and there in minute spherical concretions. The same formation exists in the same position under the quartzose outer bed and on the surface of the chalcedonic interior one, in the specimen figured in Plate III. Fig. 3; and when we find it, as we often shall in future, under similar circumstances, I shall speak of it simply as the "medial oxide." In the map, this crimson deposit is throughout represented as black.

Proceeding next to examine the inner formation on the surface of which this medial oxide is deposited, we find it composed of two parts, sharply divided; a white jasper, and dark grey translucent chalcedony. The white jasper has a spheric structure much more perfect than that of the outer coat, and so delicate as to be hardly visible without a lens (not that the spheres are small,—they are on the average the third of an inch in diameter,—but the lines of division are so subtle that the mass appears compact). In this character the inner deposit seems only a finer condition of the external one: but it differs *specifically* in being affected by sharp displacements apparently owing to contraction. To these faults, though minute, I would direct the reader's special attention. They are by no means small in proportion to the extent of material affected by them; and they differ wholly from ordinary displacements, in this, that there is no trace whatever of movement at the limiting convex curves, but only at the edge of the chalcedony—so that the fault at *a* seems owing to contraction within the space *a b*, and at *c*, to contraction within little more than the space *c d;* and farther, the fissures *a b*, *c d* are not rugged or broken, as if caused by the displacement, but sinuously current, passing on through the chalcedony from *c* to *e*, *f*, and *g;* and in fact, I am very certain that these veins are not caused by the contraction in question; but that the contraction takes place unequally on each side of the primarily formed vein. This kind of fault, of which we shall find frequent instances, the unequal contraction, namely, of beds on opposite sides of a vein or dyke, I shall call fault "by partition," and the violent fracture of beds at a point where no vein or dyke previously existed, I shall call fault "by divulsion." Deposits which fill compartments in fossil shells may often be seen, in a correspondent series of beds, to vary their proportionate thickness at each partition: the rectilinear bands of Labradorite may be found varying in thickness and position while they correspond in direction, in contiguous crystals; and I do not doubt but that even on a great scale, displacements of beds which at first sight might be supposed to have given rise to the fissures which divide them, will be found on examination to be the result of an unequal contractile action in the masses released by the fissure, protracted for long periods after it had given them their independence. Lastly. The separation of the chalcedony from the jasper does not take place only in the inner formation. It is an operation evidently subsequent to the deposition of both layers, and even in the outer one, makes the entire dotted space, as far as the curved limit X Y, chalcedonic, and flushes it with a diffusion of the medial oxide from its edges; this medial oxide here drawing itself into bands, which being parallel with those of the grey chalcedony, are manifestly produced by a segregation which has taken place simultaneously in the two layers. This being clearly ascertained, the intensely sharp line, which separates the chalcedony from the white jasper, considered as a result of segregation, becomes highly remarkable, and a standard of possibility in sharpness of limit so produced.

The spots surrounded by dark lines in the lower part of the figure are portions of the inner formation cut off by the surface section. It is often difficult on a single plane to distinguish such spaces, the truncated summits of an inferior, or, as here, remnants of a superior, bed, from isolated concretions: and it is always necessary in examining agates to guard against mistaking variation of widths of belt caused by obliquity of section from true variations in vertical depth.

All the difficulties of a geological survey sometimes meet in the space of a single flint. The gradated softness of edge in belts widened by oblique section is however usually an instant means of recognising them; but in this stone the material is so fine that the oblique edges are as sharp as the vertical ones.

I could not without tediousness proceed farther in the description of this stone; it presents other phenomena peculiar to itself; but, resuming the points hitherto stated, we may define the family of agates, which it represents, as consisting of at least two formations enclosed by quartz; the inner formation being affected by dislocations which do not pass into the outer one. Generally their colour is brownish red and white, and their main material opaque and jasperine; their chalcedony developing itself subsequently and subordinately. The crimson veins and striæ, which in some examples traverse the inner formation, will furnish us with a study of separate interest after we have obtained determinate types of other large and typical groups: the minor details in each may then be examined with a better field for comparison. For convenience sake I shall in future refer to the group described in this paper as "Dipartite jaspers." Their division may, indeed, be into more than two coats or formations, but the operation of a contractile force in one, which does not affect another, sufficiently justifies the term for general purposes.

III.—FORMATION OF VALLIES. A DESCRIPTION OF HEUDESHOPE.

By S. R. PATTISON, F.G.S.

THE Heudeshope beck is a small feeder of the Tees, running swiftly down a steep valley into the main stream, at Middleton Teesdale. It is wholly in the lead-measures (Carboniferous limestone), which are here nearly horizontal, undisturbed by trap, and shew only a few faults, so small as not to affect the surface. The great Teesdale fault operates on the other side of the main valley. The Heude beck flows north and south. Its source is in the table-land, forming the water-shed, between Weardale and Teesdale, whence four or five streams issue in different courses. It is unobscured by the drift beds, which characterize the opposite lower slopes of the Tees valley. It is excavated down to the solid rock, the banks have been quite undisturbed by cultivation. It passes through forty-three distinct alternations of grit, shale, and limestone, to each of which the miners have given a distinct name; it falls about 1,000 feet in the six miles of its course, In the hope that a tramp down by the side of its brawling rivulet, during the short hours of a winter day, might illustrate some theory of valley-formation, I devoted one of the last days of the year to the task.

The summit of the table-land is formed by grit beds, called Firestone, stratigraphically just below the Millstone grit. The gorge begins by two scoop-like hollows, springing from the level. These are covered with sharp blocks of unrolled, unscratched stone. There is no nick in the table-land, no change of strata, no fault.

The plateau bears no mark which offers the slightest reason why the four or five tiny streams should have originally flowed in one direction rather than another. But the crust of the plateau has been broken up in the direction of the valleys, and the uppermost reaches are incumbered by untravelled blocks of the grit which have been somehow broken in situ and then left. What effected this operation? Certainly not denudation, not rain or rivers, not atmospheric agency. These are minor polishing agencies, but they could never originate the basis of their operations. Not ice, for there is no trace of glacial grinding action. Looking from this summit level at the diverging lines of ruin, one would say, here we are at the spot where force has come to its vanishing point. Some great pounding and crushing and disturbing operation has radiated from the line of the river vallies below, and spent itself in the everlasting hills; the maximum of the force was displayed at the base, in the main valley below, and its minimum up here at the summit; the intervening wedge of material was shattered and loosened, leaving to rain and rivers the operation of its removal. The latter have done the barrow-work, but the powder-work was first done. After descending through about 100 feet of grits we come to the shales (Plate and grey beds), in which the stream becomes more peaceful, we then re-enter a sandstone sill, down a succession of steps, in which the perpendicular is formed of shales and the steps of grit, the former constantly yielding and the latter breaking, so as to deepen the gorge, now in one place and then in another. Crossing the thin fell-top limestone, we came into a well-marked succession of slate sills and grits. On looking around we see that the tiny rivulet has, and has always had, a definite course. True, it skips about, now here and now there, within limits of a dozen yards, now coursing down one channel and then another, as its broken ledges, or as floods determine, but its course is at the bottom of the gorge, and is quite distinct from the gorge itself, which has sloping sides; it is a water staircase, like the celebrated Cascade at Chatsworth, but with smooth inclined side walls. The whole dip of the strata is eastward, and therefore if the valley had been excavated by water or by rain it would have gone in the direction of the first shale bed, and been marked by an overhanging cliff of grit in its down eastward course. On reaching the limestone, which is here called the Great Limestone (the cliffs of which gives name to the middle of the little valley, the Skears, but which is not the Scar limestone of other districts) we find a beautiful development of the cutting-back power of the water. The beds of the limestone have first been worn quite smooth, leaving the corals and Brachiopods in exellent relief, the spray has hollowed out the shales beneath, the limestone has given way, the rivulet has suddenly acquired a new level, the old bed with its lips and pot-holes and curved lines is left dry, like a broken well-dish. This action is confined to the staircase; it does not extend back into the side slopes, The amount of river bed thus acted on is very considerable. Judging from rough calculation, it must have been going on for ages before the Boulder-clay. This trituration, with its step-like results, is quite distinguishable in its effects from the phenomena of the slopes extending upwards on either side of the actual present and past channel. The limestone forms, as usual, a terrace in the side of the fells, and shews picturesque cliffs. Below this we get pale flaggy beds with shale, the former exhibiting fine markings of two species of Crossopodia. Through these the burn descends past the village of Middleton down to its junction with the river, in the four fathom limestone.

I closed a pleasant day's ramble in the conviction that we had not made much progress in the valley question since the days of Hutton, simply because a physical fact once ascertained becomes an axiom. What more can be said than the following:—"The original inequalities of the surface, and the disposition of the strata, must, no doubt, have determined the water-course at first; but this does not hinder us from considering the rivers as having modified and changed those inequalities, and as the proximate causes of the shape and configuration which the surface has now assumed."—*Playfair, Illustrations of the Huttonian Theory*, p. 357.

IV.—On the Albian, or Gault, of Folkestone.

By C. E. De Rance, of the Geological Survey of England and Wales.

FROM the proposition of Professor Forbes, that a species once extinct never reappears, it follows that when a species recurs, it must have existed elsewhere during the whole of the time occupied by the deposition of the strata between the deposits containing it. In viewing the distribution of species through the chief stages of the Lower Cretaceous system, it appears that the same species reappear when there is a recurrence of the same or similar physical conditions,—the Neocomian and Albian clays having more species in common than the intervening Aptian; and the Aptian and Cenomanian sands, being more closely allied than the intervening Albian clay. An examination of the latter, at Folkestone, appears to allow of its being divided into eleven lithological stages or beds which have been more or less recognized by all geologists and fossil collectors who have visited the district. To these beds provisional names have been assigned expressive either of their colour, position, or characteristic fossils. But in tracing all the recurring species from their genesis in one stratum to their extinction in another, these beds are found to have no great palæontological value, but to resolve themselves into two groups divided by a junction bed, in the same way as the "junction bed" separates the Albian from the Upper Aptian. Beds I. to III. forming an Upper, beds V. to X. a Lower Albian, beds IV. and XI. being the two phosphate junction beds,

As Mr. Judd,[1] in his admirable paper on the "Speeton Clay," has adopted D'Orbigny's term, "Neocomian," for that formation, the following terms have been used by the writer of this paper as being more uniform with it:—

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[1] Geol. Mag. Vol. V. p. 141.

Danian Stage =Upper Chalk.
Zone of ——— =*Chalk rock.*
Upper Turonian sub-stage =Lower Chalk.
Zone of *Belemnitella mucronata* =*Junction bed.*
Lower Turonian sub-stage =Grey Chalk.
Zone of *Scaphites æqualis* =*Chloritic Marl.*
Cenomanian stage =Upper Greensand.
Upper Albian sub-stage =Upper Gault.
Zone of *Am. Beudantii* =*Nodule bed.*
Lower Albian sub-stage =Lower Gault.
Zone of *Am. interruptus* =*Junction bed.*
Upper Aptian =Folkestone beds.
Zone of *Rhynchonella sulcata* =*Junction bed.*
Middle Aptian =Sandgate beds.
Zone of *Terebratula oblonga* =*Junction bed.*
Lower Aptian sub-stage =Hythe beds.
Lower Neocomian sub-stage =Atherfield Clay.

A "true 'junction bed' represents in a tangible form the actual break in organic life between two stages, and either introduces a new fauna altogether, as Bed XI., separating the Aptian from the Albian stages; or contains a 'limit fauna,' as Bed IV., dividing the Upper from the Lower Albian sub-stages. Some species have an extremely limited vertical range in a stage or sub-stage, and yet reappear in other stages, producing the phenomenon of recurrent forms and horizons." Thus there are two distinct horizons of *Pecten asper* in the Albian of Kent, and another in the first foot of Greensand below the Chloritic Marl or Zone of *Scaphites æqualis* at Beaminster and Chardstock. As an assemblage of horizons of similar range constitute a zone, a recurrence of several horizons defines or marks a recurrent zone, which, as above stated, appears to occur at every return of similar physical conditions. The junction beds between all the stages and sub-stages of the Cretaceous are examples of this, for they contain in addition to the "initiative" or "limit" fauna, as the case may be, a large percentage of forms peculiar to themselves, thus the reptile *Icthyosaurus campylodon* is found in every junction zone, from the zone of *Rhynchonella sulcata*, between the Upper and Middle Aptian (Folkestone and Sandgate beds), to the zone of *Belemnitella mucronata*, between the Upper and Lower Turonian (Lower and Grey Chalks). Many other species occur in a similar manner; *Solarium conoideum*, which is limited to the upper three feet of the zone of *Ammonites Beudantii* (between the Upper and Lower Albian), even reappearing in the zone of *Scaphites æqualis* and *Am. varians* (Chloritic Marl) at Cambridge. Associated with these recurrent species, in every junction bed, are found phosphatic nodules, those from the Albian beds IV. and XI. are rich in phosphates and contain sulphuret of iron, silica, and lime, the phosphatic matter appears to have been deposited in a decomposed or gelatinous state, for it often entirely surrounds shells, bones, bored wood, and crustacea, sometimes entangled with and around fragments of broken ammonites, sometimes filling up empty cavities, and in few cases enclosing small quartz pebbles. Taking all these facts into consideration, it appears probable that these phosphatic nodules are the molluskite and other animal remains of the recurrent forms which existed in another area during the time occupied by the deposition of the intervening strata.

The Lower Neocomian is exposed at low water on the beach between Sandgate and Hythe, and is reached in well-borings at both towns; the zone of *Rhynchonella sulcata* is to be seen near the turnpike between Folkestone and Sandgate, on the Lower Sandgate Road; the Middle Aptian beds at this point are overlaid by a recent deposit, two to three feet thick, which contains the empty shells of the recent species *Cyclostoma elegans*, a shell, peculiar to chalk districts, only now met with living, two miles further east, on the chalk of the undercliff at Eastweir Bay. The Upper Aptian sands, with its seams of rag and sandy ironstone, form the cliff above. The junction bed XI, is first seen in the cliff, at a point immediately over the before-named turnpike. Under the junction bed, at the top of the Upper Aptian, there is a highly fossiliferous bed (the zone of *Ammonites mammillaris*, *Am. Beudantii*, and *Inoceramus Salomoni*). This zone, which contains many Aptian forms, is succeeeded by a seam of sulphuret of iron nodules, with crystals of selenite, and occasionally wood, bored by *Gastrochæna pyriformis;* this seam is a portion of the junction bed XI., and is the real base of the Gault Clay, or Albian stage.[1]

LOWER ALBIAN.

Zone of Ammonites interruptus. Bed XI.—This zone consists of three portions, the iron seam, before alluded to; a seam of dark green sand, containing two lines of phosphatic nodules; and a band of dark marly gault, with one line of nodules; the nodules in each case being mixed with fragments of *Am. interruptus* and *Am. dentatus*. The first portion is generally about a foot in thickness, the second from eighteen inches to four feet thick, the third from one to three feet. This zone is well shown in the cliff section, from its first appearance above the turnpike, before-mentioned, to the point in which it sinks below the beach, a little east of Copt Point. At the eastern corner of the west cliff, at the Battery, it is cut into and redeposited with the local "Elephant" bed existing at that point, of which the following is a section taken by the writer of this paper in 1866:—

1.	Vegetable mould..	3 feet 3 inches.
2.	Rag flagstones of Old Monastery	0 „ 3 „
3.	Clay, with oysters, bones of Ox, etc..............................	2 „ 6 „
4.	Small shingle	0 „ 4 „
5.	White loam, with *Helix concinna*, *Succinea oblonga*. Lower Chalk. *Terebratula*, and "junction bed." *Ammonites* and nodules	6 „ 4 „
6.	Angular flints, with bones of mammalia, and fragments of *Am. interruptus*	1 „ 6 „
7.	Upper Aptian	95 „ 0 „

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[1] For the particulars of the distribution of the Aptian beds, see Mr. Drew in Geol. Survey, Memoir on sheet IV.

The last set of bones found were exhumed in the presence of Captain Sweeney, R.A., who told me they were found in bed 6 of this section, two or three large tusks of *Elephas primigenius* being left at the bottom of the excavation, where they remain to this day. A similar deposit to that of bed 4 of the above section, was found in an excavation for some cottages, between the New Gas Works and Railway Embankment; this deposit, capped by brick earth and resting on Upper Aptian, contains Lower Chalk fossils and nodules of iron from the Chalk.

The junction bed XI, may be well seen on the Canterbury Road, in a sand pit, a little south of the brickfield above the Red Cow Inn; the zone of *Am. interruptus* resting here on the zone of *Am. mammillaris*, at a height of forty feet above the road. At the gate leading to the brickfield it dips under the road, and is never met with at the surface further north. It was, however reached in a well-sinking at Canterbury Terrace, Dover Road, at a depth of eighty feet. The two upper bands of bed XI. were three feet six inches, and the sulphuret of iron seam eighteen inches in thickness; water was touched the moment the latter seam was pierced, and welled up in abundance after passing through five feet of dark greensand, resembling in lithological character the beds of the Middle Aptian.

Zone of Ammonites Benettianus (?) Bed X.—The "bottom bed" of the Albian contains one seam of phosphatic nodules, with few organic remains.

Zone of Am. auritus, var. Bed IX.—The variety of *Am. auritus* found in this zone has long and slender spines. The zone is well shown in the Copt Point section, in the patch of Albian exposed on the beach in the Eastwear Bay, between Copt Point and the Preventive Station, and in the Brickfield before mentioned.

Zone of Crustacea. Bed VIII. ("Crab-bed") is composed of a light fawn-coloured clay; a striking contrast to the deep black of zone IX., and is poor in fossils in proportion to its thickness, but contains seven species peculiar to itself.

Zone of Nautilus Clematinus. Bed VII.—The clays of this zone are strongly spotted with light markings of fawn colour on a dark ground; this kind of mottling is invariably found in the clays of the Lower Albian; on the contrary, in the Upper Albian, the clay deposits are streaked (not spotted), with dark marks on a light ground. Many characteristic Albian shells make their first appearance in this zone, and seven are peculiar to it.

Zone of Am. denarius. Bed. VI. though of small vertical thickness and lithologically similar to the last, is palæontologically distinguished from it, from the fact that many of the most marked forms of zone VII. do not pass into it, while on the other hand it contains at least six species peculiar to itself. This zone is well seen in plan, in the patch of Albian on the beach; it is there distinguished from the last by the darker colour of the ground between the mottlings, and is physically separated from the following zone by a seam of hard rag about six inches thick.

Zone of Am. auritus. Bed. V. is very dark in colour, though not so dark as the zone of *Am. auritus var.*, and is highly fossiliferous. Two distinct forms of *Ammonites Deshayesii* occur in the lower Cretaceous series, one with a square flat back, the other with a rounded back. The former occurs in the zone of *Rhynchonella sulcata*, and the sand seam in the zone of *Am. interruptus;* the latter form in the Lower Neocomian clay of the Isle of Wight, and the clay of the Lower Albian, zone v., at Folkestone. Zones v., vi., and vii. constitute the horizon of *Ammonites elegans*, whilst that of *Am. lautus* probably corresponds with the entire space occupied by the Lower Albian.

Zone of Am. Beudantii. Bed. iv. being the "passage" between the Upper and Lower Albian, cannot be strictly said to belong to the one more than to the other. It marks the total extinction of many Lower Albian forms, no less than the introduction of others, which took their place. But this replacement is marked rather by a greater number of individuals, than of species, for of the 88 species which became extinct in the Lower Albian, only 45 new forms occur as peculiar species to the Upper Albian. Zone iv., in addition to being the "limit fauna" of the two Albians, contains 13 species peculiar to itself, and also the other 13 species which are common to the Upper and Lower Albians. We thus see how well the Upper Albian is specialized by the group *Cristati*, not a single specimen of which is found in the Lower Albian; whilst with the exception of *Am. splendens*, the Lower Albian is equally characterized by the *Dentati* and *Tuberculati*—bed xi. being especially the zone of the former, and beds vii., vi., and v. of the latter. This zone, as seen in the patch on the beach, consists of four portions. The lower, five inches at the outcrop, contain phosphatic nodules with *Am. proboscideus;* the second, 18 inches thick, nodules with variety of *Am. denarius* (*Am. crenatus* of the Brit. Mus. coll.); the third, four feet four inches, with few nodules and *Am. Bouchardi;* the fourth, two feet, with nodules and *Am. Beudantii*, constituting four well defined Ammonitic horizons.

UPPER ALBIAN.

Zone of Nautilus Deslongchampsianus. Bed iii. is at once distinguishable from any other by the occurrence of *Inoceramus sulcatus*, in casts, in great abundance, the surface of the bed being everywhere marked by their silvery impressions. This shell first occurs in the Lower Neocomian clay of Hythe, is not again found in the Aptian series, but re-appears in the zone of *Am. interruptus;* a single specimen only, however, has been found by Mr. Etheridge.[1] It next appears sparingly in bed iv., and reaches its maximum of development in bed iii., the zone under consideration. A few specimens occur in bed ii., and also in the Blackdown beds, a portion of which, at least, represents the Upper Albian. Near the base of zone iii. there is a seam of phosphate containing *Nucula bivirgata* and *Cardita tenuicosta*, *Inoceramus sulcatus*[2] and a quartz pebble. A little above is a seam of hard rag containing stems of *Pentacrinus Fittoni*. Another bed of rag, physically dividing this zone from zone II.; immediately under the rag is a seam of very large specimens of *Am. cristatus.*

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[1] Memoir of the Geol. Survey, sheet iv.

[2] A distinct variety of *In. sulcatus*, figured in "Mollusques Fossiles," by Pictet

Zone of Am. circularis and *Kingæna lima.* Bed II. In colour a pale cold grey, poor in organic remains, but containing several seams of phosphatic nodules mixed with fossils; these nodules appear to be the principal cause of the preservation of as many as fifteen peculiar species of fossils. Before describing the position of these, the following is a key to the beds before named, exposed on the beach; the measurements give the width of outcrop of each zone, along a line at right angles to the coast from the cliff to a large chalk rock marked by the writer with a broad arrow.

	FT.	IN.		FT.	IN.		FT.	IN.
Zone I.... ..	56	10	FAULT.			FAULT.		
—— II......	81	7	Zone II......	37	0	Zone V.........	20	0
—— III......	11	5	—— III......	8	6	FAULT.		
—— IV......	8	4	FAULT.			Zone VIII......	35	0
—— V......	23	0	Zone V.......	8	1	Sand, covering		
—— VI......	3	0	FAULT.			Albian	90	0
—— VII......	10	10	Zone VII......	2	0			

The first seam of phosphate in zone IV. occurs at 5 ft. 6 in. above zone III. in the patch on the beach; it is there 4 in. thick, and contains *Ino. concentricus* and vertebræ; the second, a foot thick, occurs at 4 ft. 9 in. above the last, and contains *Terebratula biplicata, Nucula ovata, Am. cristatus, Hybodus, Lamna subulata,* vertebræ, *Hamites attenuatus, Pentacrinus Fittoni, Nucula bivirgata,* and *Pecten asper.* About the middle of this zone there is a very dark band, well seen at the foot of the cliff section, a little west of the Preventive Station and east of the great patch on the beach, which contains no less than five seams of phosphate nodules in about as many feet; these constitute the horizon of *Belemnites* (*minimus*) *ultimus* and *Hamites armatus,* they also contain *Am. cristatus* and *Am. varicosus.*

Zone of Am. Goodhallii, and *Am. rostratus.* Bed. I.—This zone is traversed by a system of joints, with smooth surfaces which are coated with a film of oxide of iron, or "dark partings." These smooth surfaces slipping against each other, partly contribute to the faulted and folded state of the beds beneath; the whole base of the cliff, a little west of the Preventive Station, sometimes moving a foot in a week, the upper bed folding over, and reaching more seaward than the lower beds. In connection with the unstable state of the undercliff in the bay, it may be mentioned that the whole surface of the land between Martello Tower 3 and the Tramroad, is slowly sinking, and in the line of greatest depression, according to the Coastguard men, at the rate of a foot in a year. Zone I. is divided into two portions by the occurrence of a bed of dark green sand, containing four seams of shining phosphatic nodules. It contains *Am. Goodhallii, Icthyosaurus campylodon, Pecten orbicularis, Belemnites ulti-*

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and Roux, pl. 42, *fid*, exists in this seam, two specimens being found, half of the shell resembling *sulcatus* and half like *concentricus.*—C. E. R.

mus, and a Choanite; the latter three species were obtained by Mr. Topley.[1] All the species enumerated from zone I., occur in that portion of it, under the horizon of *Am. Goodhallii.* A fragment of a Pecten from the upper portion, appears to be a Lower Turonian species.

CENOMANIAN.

This formation is 28 feet thick at Copt Point, the first 22 feet being green sand and the remaining six brown sand. It runs from this point to the air shaft of the tunnel, and from thence along the undercliff capping the cliff section west of the Coastguard Station, and occurs all along the beach a little east of the same, between the cliff and the little patch of Albian beds I. and II., locally called "Pelter Gault."

The following fossils were collected by Mr. Topley and myself from the Cenomanian of Folkestone:—*Brachiolites* (?), *Solarium ornatum*, *Inoceramus Crispii* (?), *Ventriculites impressa*, *Exogyra conica*, *Ex. columba*, *Pecten orbicularis*, and *Lima parallela.*

Zone of Scaphites æqualis.—The "Chalk with green grains" or "Chloritic Marl," is seen at Folkestone, in the inlier at Copt, where it occupies a small circle around the Martello Tower. It is apparently unfossiliferous, and is five feet in thickness.

The Lower Turonian sets in near Martello Tower 2, and is well exposed on the beach at Abbots' Cliff. The Upper Turonian forms the escarpment overlooking the Aptian plateau; and the Danian first appears at the top of the cliff a little west of the Preventive Station at Abbots' Cliff.

In conclusion, I would wish to thank Mr. Etheridge for his kindness in determining the species of the majority of the fossils, and for his assistance in various ways.

List of the most Characteristic Species peculiar to each Zone.

Zone XI.—(7 Species peculiar.) *Am. Deshayesii*, *Am. dentatus*, *Am. Gervillianus*, *Trochosmilia sulcata.*

Zone IX.—(5 sp. p.) *Mytilus Galliensis*, *Fusus Iterianus*, *Scalaria Dupiniana.*

Zone VIII.—(9 sp. p.) *Pinna tetragona*, *Turbo decussatus*, *Ampullaria lævigata*, *Etyus Martini*, *Palæocorystes Broderipii*, *Hoploparia longimana*, *Otodus appendiculatus.*

Zone VII.—(7 sp. p.) *Hamites tuberculatus*, *Ham. Sablieri*, *Gervillia solenoides*, *Rostellaria varicosa*, *Bellerophina minuta.*

Zone VI.—(6 sp. p.) *Trochocyathus conulus*, *T. Harveyanus.*

Zone V.—(17 sp. p.) *Ham. simplex*, *Pecten quinquecostatus*, *Actæon affinis*, *Avellana inflata*, *Rostellaria Robinaldina*, *R. carinella*, *R. cingulata*, *Acmæa tenuicosta*, *Turbo* allied to *Yonninus.*

Zone IV.—(13 sp. p.) *Am. versicostatus*, *Rost.* allied to *pyrenaica*, *Pleurotomaria Gibbsii*, *Cyathina Bowerbankii*, *Edaphodon brevirostris* (?), *Pycnodus.*

Zone III.—(2 sp. p.) *Palæocorystes Stokesii.*

Zone II.—(15 sp. p.) *Hamites elegans*, *H. armatus*, *Kingæna lima*, *Adelia Bechei.*

Species Characteristic of Lower Albian.—*Belemnites attenuatus*, *Rostellaria carinata*, *R. Parkinsoni*, *Turritella granulata*, *Phasianella Gaultina*, *Pterocera retusa*, *Cyclocyathus Fittoni.*

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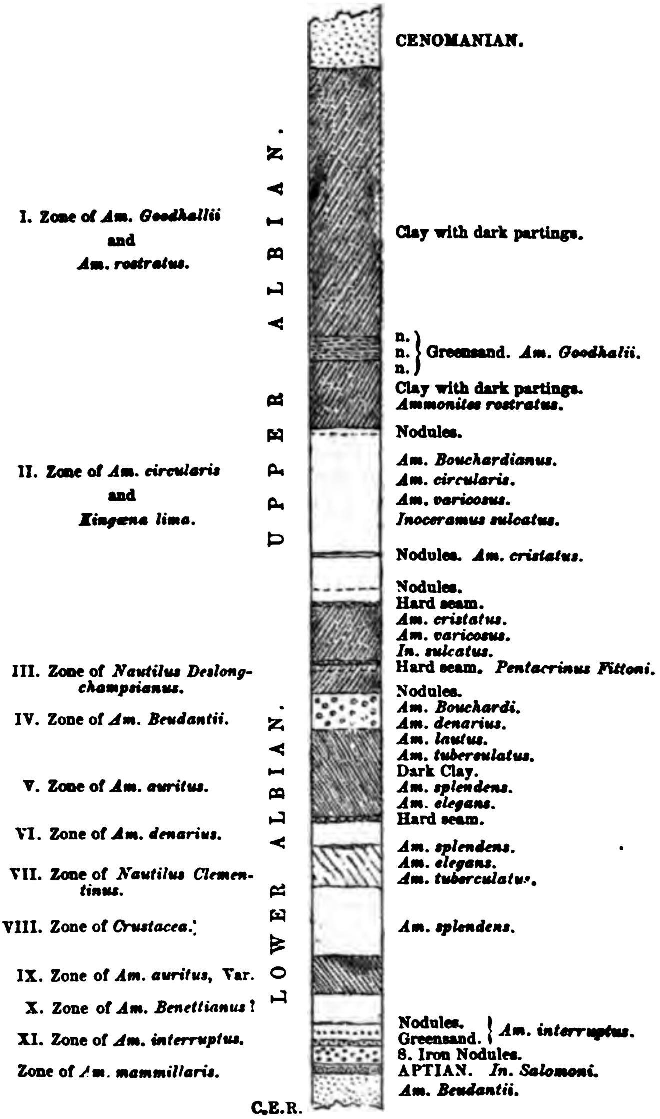
[1] Who also obtained *Trochocyathus conulus*(?) from it.—C. E. R.

Species Characteristic of Upper Division.—*Am. Bouchardii, Inoceramus sulcatus, Pecten asper.*

Species Characteristic of Lower and Upper Albian. — *Hamites rotundus, Terebratula biplicata, Inoceramus concentricus, Nucula pectinata, N. ovata, N. bivirgata, Pentacrinus Fittoni.*

SECTION OF ALBIAN OR GAULT AT COPT POINT, FOLKESTONE.



The following Table exhibits a summary of the species common to the Upper and Lower divisions of the Albian or Gault, of those peculiar to each, and of those also which mark the zone of *Ammonites Beudantii*, or the "passage-bed" between the Upper and Lower Albian. A list of all the species, with their ranges, will, I believe, be printed in the Survey Memoir on Sheet III.

	Species which occur in both Upper and Lower Divisions.	Species peculiar to the Lower Division.	Species peculiar to the Zone of *Am. Beudantii.*	Species peculiar to Upper Division.
PLANTÆ:				
Fucoids and wood	1	0	0	1
FORAMINIFERA	0	1	0	0
RADIATA:				
Zoophyta	1	7	1	0
Echinodermata	1	1	0	3
ANNELIDA	0	0	0	2
CRUSTACEA:				
Cirripedia	0	1	0	2
Decapoda { *Macrura*	0	2	1	1
Decapoda { *Brachyura*	0	2	0	2
MOLLUSCA:				
Brachiopoda	1	1	0	2
a. Monomyaria	2	9	0	6
b. Dymyaria	5	8	1	2
Gasteropoda	2	24	4	2
Cephalopoda:				
a. Ammonitidæ	4	18	4	17
b. Nautilidæ	0	2	0	1
c. Belemnitidæ	1	1	0	1
PISCES	1	5	2	3
REPTILIA	1	0	0	1
	20	82	13	46

P.S.—The species found in the true Gault or Albian of Black Ven, Dorset, are those of the Lower Division.

COAL IN NEW ZEALAND.—On the suggestion of Dr. Hector, Captain Hutton, F.G.S., has been making a survey of the Lower Waikato district of the North Island. He reports that there is no probability of finding a payable alluvial gold-field of any extent, but that the district has other deposits of value. The Tertiary formation contains "brown coal," having the appearance of cannel coal, lustrous and pitch black in colour, with brown film in places. It is a hydrous coal, still containing a certain per-centage of water, but it is found to answer well in the steamers on the Waikato. It burns with a bright, clear flame, throwing out an intense heat. Captain Hutton estimates the coal bed to contain 140,000,000 tons of coal. The whole can be worked without pumping or any mechanical means for raising it to the surface, and therefore it can be supplied at a light cost.

V.—THE FOSSIL INSECTS OF NORTH AMERICA.

By SAMUEL H. SCUDDER, Curator of the Museum of the Boston Society of Natural History, U.S.

THE discovery of fossil insects in North America is of very recent date; even now, scarcely a hundred specimens have been brought to light, and they have occurred, with few exceptions, as solitary individuals. The Reports of State and provincial geologists, which have added so richly to our knowledge of the palæontology of North America, have hardly mentioned these fossils. As descriptions of them are scattered through many publications—doubtless difficult of access to English geologists—and as most of the specimens referred to have passed under my eye, I have prepared this general *resumé* of what is known and have accompanied it with critical remarks.[1]

The oldest fossil insects yet discovered in America—and, indeed, in the world—consist of a few broken wings of Neuroptera, imbedded in the Devonian rocks of Lancaster, New Brunswick. The locality —"Fern Ledges"—so called by Mr. C. F. Hartt, the discoverer of the remains, is about a mile west of the town of Carleton, not far from St. John. The rocks form a series of ledges, exposed on the sea shore between high and low water marks. The beds of sandstone and shale, of which they are composed, have a seaward dip of about 45° and a strike of about W. 10° N., corresponding very nearly to the trend of the shore. The fossiliferous shales between the enclosing sandstones are worn away by the action of the water, leaving the fossils accessible in but few places. The whole deposit is of very limited extent; it reaches along the shore for about three hundred and twenty-five paces, exposing a thickness of strata of one hundred and forty-five feet, with a width of some three hundred feet.

Mr. Hartt has given a detailed description of these strata, from which the following section, showing the position of the fossil insects, is derived:—[2]

Sandstones and shales	*Calamites* and obscure markings	23 ft.
Fine-grained, light-greenish shales	Obscure markings	1 ft.
Sandstones and coarse shales	*Cordaites* (two sp.) and *Pecopteris*	26 ft.
"Plant Bed No. 8."[3] Fine-grained, tough but fissile sandstones, rather coarse shales, often of a greenish cast, and, at the top, a thin layer of very black shale, very rich in plants—the lower portion filled with remains of plants like the leaves of an herbarium	*Cordaites* (three sp.), *Asterophyllites*, *Annularia*, *Pinnularia*, *Lycopodites*, *Cyclopteris* (two sp.), *Neuropteris*, *Hymenophyllites*, *Pecopteris* (two sp.), *Cardiocarpon* (three sp.), and several other undetermined plants. INSECTS: *Homothetus fossilis*, *Dyscritus vetustus*, and *Lithentomum Harttii*	1 ft. 10 in.

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[1] A short account of these discoveries of Insect remains in North America was given by Principal Dawson, LL.D., F.R.S., with some figures of the same in Vol. IV. of the GEOLOGICAL MAGAZINE, September, 1867, p. 385.

[2] See Bailey's Observations on the Geology of Southern New Brunswick. Appendix A, pp. 131–141, 8vo., Frederickton, 1865.

[3] The highest in the series. I have reversed the order followed by Mr. Hartt.

Compact sandstone and coarse shales	No fossils	3 ft.
"Plant Bed No. 7." Shales, variable in character, generally grey and compact, but sometimes light-brownish or even black, fissile, and soft	Very rich in plants: *Cordaites*, *Calamites* (two sp.), *Asterophyllites*, *Annularia*, *Pinnularia*, *Psilophyton*, *Neuropteris*, *Cyclopteris*, *Sphenopteris*, *Hymenophyllites*, *Cardiocarpon* (three sp.), *Alethopteris*, and *Pecopteris* (three sp.). INSECTS: *Platephemera antiqua*	2 ft.
Sandstone and coarse shales	Abundance of plant-remains, principally *Cordaites* and *Calamites*	5 ft.
"Plant Bed No. 6." (*a*) Coarse shale of a greenish-grey colour; (*b*) soft, very friable shale; (*c*) coarse shale; (*d*) fine-grained and light-coloured shale	(*a*) *Pecopteris* (two sp.), *Cordaites*, *Calamites*, *Neuropteris*, *Cardiocarpon* (two sp.); (*b*) few fossils; (*c*) *Cordaites*, and stems of plants; (*d*) *Cordaites* and *Calamites*	2 ft.
Compact flaggy sandstones and coarse shales	Few plants	8 ft.
"Plant Bed No. 5." Soft, fine-grained, light-greenish shale	*Cordaites*, *Calamites*, *Psilophyton*, *Asterophyllites*, *Pecopteris* (two sp.), *Sphenopteris*, *Hymenophyllites* and *Neuropteris*—also *Spirorbis*	6 in.
Sandstone	Obscure markings	9½ ft.
"Plant Bed No. 4." Coarse shales	*Cordaites*, *Calamites*, *Neuropteris* (two sp.), *Psilophyton*, *Pinnularia*, *Cardiocarpon*, and other undetermined forms	1 ft.
Sandstone and coarse shales	Badly preserved remains	18¾ ft.
Light-greenish, coarse shales	Fern-stems, *Cordaites*, and obscure markings. (*Carpolithes ?*)	7 in.
Sandstone and coarse shales	Obscure markings	5 ft. 10 in.
Sandstone and shales	*Calamites* and *Cordaites*	9 in.
Sandstones	No fossils	4 ft. 10 in.
Shales	Obscure remains of plants	2½ in.
Sandstones		2¼ ft.
Soft shale and fissile sandstone	*Calamites*	3½ in.
Coarse sandstone	*Sternbergiæ* and *Calamites*	6½ ft.
"Plant Bed No. 3." Black and lead-coloured shales, compact above, crumbling below, traversed by thin quartz veins	*Calamites* (two sp.), *Asterophyllites*, *Annularia*, *Pinnularia*, *Psilophyton* (two sp.), *Cordaites*, *Cyclopteris*, *Neuropteris*, *Sphenopteris* (two sp.), *Pecopteris*, and *Cardiocarpon* (two sp.)	10 in.

Compact, flaggy sandstone	No fossils	5 ft. 10 in.
"Plant Bed No. 2." Shales, variable in character, sometimes very compact and hard, light-lead coloured, slate-like and arenaceous; at other times very soft and fissile and of a very black colour	*Calamites* (two sp.), *Asterophyllites* (four sp.), *Annularia*, *Pinnularia*, *Psilophyton* (two sp.), *Cordaites*, *Cyclopteris* (three sp.), *Neuropteris* (three sp.), *Sphenopteris* (five sp.), *Hymenophyllites* (three sp.), *Pecopteris* (two sp.), *Trichomanites*, *Cardiocarpon* (two sp.), and *Trigonocarpon;* also *Eurypterus*, *Amphipeltis*, *Trilobita*, and *Spirorbis*. INSECTS: *Gerephemera simplex* and *Xenoneura antiquorum*	1 ft.
Very soft, dark, lead-coloured shales	Fragments of plants	4 ft.
Compact, flaggy, grey sandstone	Remains of plants—*Calamites*, etc.	2 ft.
Black, arenaceous shales	No fossils	11 in.
Grey sandstones and flags	*Calamites*, *Cordaites*, *Asterophyllites*, and *Sternbergiæ*	2½ ft.
"Plant Bed No. 1." Black, arenaceous shales, varying from a fissile sandstone to a semi-papyraceous shale, very fine-grained and very fissile	Rich in plants. *Calamites*, *Asterophyllites*, (four sp.), *Sphenophyllum*, *Pecopteris*, *Sphenopteris*, *Cardiocarpon*, and *Psilophyton*.	1 ft.

These sandstones and shales rest immediately upon another series of rocks consisting of heavy beds of grey Sandstones and flags, estimated to be 300 feet thick.

This latter series of rocks has been termed "Dadoxylon Sandstone," while the former series—represented by the section—belongs to the "Cordaite Shales" of the provincial geologists. Together, they form the little river group of Matthew[1] or Nos. 2 and 3 of the Series given by Dr. Dawson in his paper on Devonian plants.[2] In other parts of New Brunswick, these rocks are of much greater importance, the Dadoxylon Sandstones attaining a thickness of 2,800 feet, and the Cordaite shales of 2,400 feet, together with the Mispeck group, which overlies them, and the Bloomsbury group, upon which they rest, they constitute the upper portion of the *Devonian* formation. The appearance of insects on our globe is thus carried back a whole geological epoch, and is made synchronous with that of land plants.

Fortunately no substantial doubt rests upon the declared age of these rocks. Dr. Geinitz, indeed, believes them to be Carboniferous,[3] but he has based his opinion upon an examination of a single specimen of one of the insects which I showed him; this was accompanied by a fern which he considered *Cyathites plumosus Artis*, and which is characteristic of the Carboniferous formation.

If, however, Dr. Geinitz's determination of this species were certainly correct, it would not invalidate the statements of geologists who refer this deposit to the Devonian, for several species of plants are stated to be common to this formation and to the Carboniferous.

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[1] Can. Nat. vol. viii., p. 244. [2] Quart. Journ. Geol. Soc. Lond., vol. xviii., p. 303.
[3] Sitzungsb. der Naturh. Gesellsch. Isis. Dresden, 1866: 22.

In evidence of the Devonian age of the fossils, we have Dr. Dawson's admirable papers upon the plant remains of these beds, given in the Quarterly Journal of the Geological Society of London for November, 1862, and November, 1863. The rocks are referred by that distinguished authority to the Chemung and Portage group of the New York geologists. Furthermore, the group of rocks to which this plant-bearing series of shales belongs, underlies unconformably beds whose Lower Carboniferous age is unquestionable. The Cordaite shales of Lancaster rest directly and conformably upon the Dadoxylon Sandstone,[1] but as the shales are the highest members of the series of rocks lying on the westerly side of Courtney Bay, we must cross to the eastward to discover the superincumbent formations.

The Dadoxylon Sandstone is composed of rocks, easily traceable throughout the province by their uniformity.[2] The overlying Cordaite shales are usually rich in metalliferous deposits, and have been very carefully explored: upon them rest conformably, more than 1800 feet of rocks, described by Dr. Dawson[3] as "dark red and greenish shales; flaggy sandstone sand grits; coarse angular conglomerate." They are called the Mispeck group, and considered the uppermost member of the Devonian series. Now these latter rocks are covered unconformably by conglomerates, which form the very base of the Carboniferous formation.[4] Special instances may be cited in the neighbourhood of Red Head[5] and at Martin's Head[6]

Great interest attaches to the insects themselves: six specimens in all,[7] each differing from the others, were discovered by Mr. Hartt. They are all *Neuroptera*.

GEREPHEMERA SIMPLEX is represented by a slight fragment on the tip of a wing; the wing must have been large and broad; the veins, distant, weak, and simple. It is apparently a member of the family of *Ephemerina*.

PLATEPHEMERA ANTIQUA belongs to the same family, although its neuration is quite peculiar, and I have never seen in a Ephemerid so much reticulation in the anal area; the intercalary nervules, which, in *Ephemerina*, generally originate independently, arise here from a bent cross-vein, much as in *Odonata*. It is a gigantic species, which must have measured five inches in expanse of wings; the fragment belongs to an upper wing, embracing all but the base and a slight portion of the tip.

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[1] Hartt, in Bailey's Geology of Southern New Brunswick, p. 134.

[2] Bailey. Geology of Southern New Brunswick, p. 55.

[3] Quart. Journ. Geol. Soc. Lond., 1862, p. 302.

[4] Bailey. Geology of Southern New Brunswick, pp. 77 and 80. Dawson. Quart. Journ. Geol. Soc., Lond., 1865, p. 98.

[5] Quart. Journ. Geol. Soc., Lond., 1862, p. 302.

[6] Bailey. Geology of Southern New Brunswick, p. 96. I have been particular in my references to authorities, because if the determination of these rocks prove correct, a whole class of animals, hitherto known as early as the Carboniferous, are referred at once to a previous epoch.

[7] A brief notice of these remains was given in Professor Bailey's Geology of Southern New Brunswick, published in 1865, and short descriptions and figures have been furnished to Dr. Dawson for the new edition of his Acadian Geology. See also Sill. Amer. Journ. Sc. and Arts [2] xliv., p. 116; and GEOL. MAG., 1867, Vol. IV., p. 385, Pl. XVII.

DYSCRITUS VETUSTUS is represented by a very small fragment, broken probably from the middle of a wing, near the base, or not far from the division of the middle and anal areas; but, while its characters are clear enough to distinguish it with certainty from the other specimens, it is impossible to determine either the approximate size of the insect or the family to which it belongs.

LITHENTOMUM HARTTII was the first specimen discovered by Mr. Hartt. It is a fragment from the central portion of the wing, giving the extension of the principal veins towards the base and along the costal border. Apparently, it does not belong to any family of *Neuroptera* represented among living forms, but agrees more closely with *Hemeristina*, a family which I founded upon a fossil insect discovered in Illinois, and of which I shall shortly speak. It differs from *Hemeristina* both in the mode of division of the nervures and in the peculiar cross-veining of the wing, and probably comes between that family and the *Sialina*. I think that the fragment is a piece of the lower wing, and that the insect, when expanded, probably measured about three and a half inches.

HOMOTHETUS FOSSILIS is represented by the greater portion of the upper wing; although it is in a mutilated condition we can determine the extent and character of every principal nervure. At first sight, it seems to be an abnormal member of the *Sialina*, but, in reality, it is the representative of another new family, synthetic in nature, combining features of the *Odonata* and *Sialina*. These latter families are members each of different groups, and are thought by some naturalists to belong to different orders. The feature which bears the strongest resemblance to the *Odonata*, and which, in fact, has never been noticed in any other family, is a heavy cross-vein near the base of the wing, between the two principal middle nervures, from which cross-vein new prominent veins take their rise.

XENONEURA ANTIQUORUM is the last, and perhaps the most interesting, of all these fossils. It is the basal fragment of a wing, smaller than those which we have mentioned, expanding probably about two inches; the neuration is peculiar throughout, so that, like the two preceding specimens, it must represent a new family of *Neuroptera*. The most striking peculiarity is the development of apparently independent veinlets, forming portions of concentric rings at the base of the wings. There is nothing analogous to it among living *Neuroptera*, and I can only compare it to the stridulating organ of some male saltatorial Orthopteron. Is it possible that this insect was a member of a group forming a synthetic type between *Orthoptera* and *Neuroptera*?

The Carboniferous formation has yielded several localities of fossil insects in America.

One of these insects was described and figured by Professor Leo Lesquereux[1] under the name of BLATTINA VENUSTA. It is the upper wing of a cockroach, and was found in the Coal Measures of Frog Bayou, Arkansas, The following section, which I owe to the favour of M. Lesquereux, will give an idea of its stratigraphical position :—

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[1] Owen's Second Report of a Geological Reconnoissance of the Middle and Southern Counties of Arkansas, p. 314, pl. v., fig. 11., 8vo. Philadelphia, 1860.

Millstone Grit	200-300 ft.
Shale with *Cordaites* and *wing of insect*	2 ft.
Frog Bayou Coal	2 ft.
Sandstone with *Sigillaria Stigmaria*, etc.	12 ft.
1st Archimedes Limestone	30 ft.
Sub-Carboniferous Sandstone	30 ft.
2nd Archimedes Limestone	20 ft.

An upper wing, quite similar to the foregoing in general appearance, was recently discovered by Mr. James Barnes in the coal measures of Pictou, Nova Scotia. It differs from *Blattina venusta* in the curve of the costal border—affecting the direction of nearly every vein in the wing—as well as in the extent and direction of the mediastinal vein and in the distribution of the veins in the anal area. Nor does it agree even generically, so far as I can determine, with any of the fossil cockroaches enumerated by Giebel in his Fauna der Vorwelt, so that I have considered it the type of a new genus. Through the favour of Dr. Dawson, I have been permitted to examine this fossil. It will be described and figured under the name of ARCHIMULACRIS ACADICUS in the forthcoming edition of his Arcadian Geology.

Several years ago, a wing—possibly of the same species—was found at the Joggins, Nova Scotia, by Professor Marsh, of New Haven. According to his recollection, it was similar in appearance to Lesquereux's *Blattina*, but it was packed away at the time of its collection, and has never since been examined.

Mr. Barnes has discovered another wing of very great interest; it was obtained in the Coal-measures at Schooner Pond, Cape Breton, on Ross's Lease, two feet above a seam of coal. Dr. Dawson kindly sent me a photograph of the wing; it will be described in his Arcadian Geology under the name of HAPLOPHLEBIUM BARNESII. The wing is quite well preserved, although the base is not present and a portion of the apex is concealed by a fern leaf; it is very long and narrow, giving an expansion to the insect of fully seven inches. The extreme simplicity of the neuration probably places this insect among the *Ephemerina*, although the form of the wing, and the reticulation which appears vaguely on the photograph, recall the *Odonata;* other features of the wing resemble the *Odonata*, and it is not impossible that *Haplophlebium* forms a synthetic type, combining essential characters of *Odonata* and *Ephemerina*.

[3] See also Sill. Amer. Journ. Sc. and Arts. [2], xliv., p. 116.

(*To be concluded in our next.*)

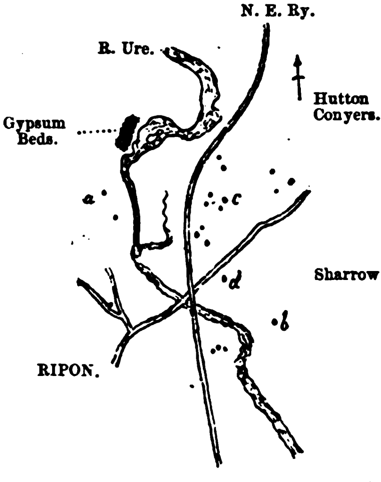
VI.—On certain Natural Pits in the Neighbourhood of Ripon.

By the Rev. J. S. Tute.

NEAR the city of Ripon, on both sides the river Ure, but more particularly on the eastern side, there are a great number of natural pits, probably fifty or sixty, the origin of which appears to be very obscure.

They chiefly occur in groups of two, three, or four, in the lowest beds of the New Red Sandstone, and the overlying drift-gravel; but there are some also in the Magnesian Limestone. Their general form is crater-like, with a diameter of 40 to 100 feet, the sides having a slope of about 30°. But, in one instance (marked *c* on the plan), the pit consists of a perpendicular shaft about 30 feet in width and 60 in depth, cut through the New Red Sandstone. Here the gravel bed is very thin. In another, close to this one, the crater-like hollow terminates in a sandstone shaft, which is nearly filled with water. In a third, *a*, the sides of the pit, which occurs in the Magnesian Limestone, are perpendicular on one side, but slope gradually down to the bottom on the other. The limestone is thinly-bedded, and in small slabs, dipping evenly to the east, about 5°.

Plan Exhibiting the Localities of the Principal Pits.



Scale—1 inch to a mile.

The crater-like form of these pits is evidently due to the falling in of the sides when a pit has occurred beneath the gravel; though in what manner the pits themselves have been formed is very difficult to understand. That they are due in some way to the action of water is probable, as they seldom, if ever, occur more than half a mile from the river; and several of them now contain water. The Magnesian Limestone in the neighbourhood is full of cracks, and swallow-holes, and subterranean passages. If any of the overlying rock gave way, this would produce rather irregular subsidences, than such regularly formed pits as these are. The structure of the New Red Sandstone will be understood best from the following copy of a well-sinker's report of a well sunk 28½ yards deep, very near to the pit marked *d*:—

"After cutting through the soil, which is not very thick, a soft sandy red rock, 10 feet thick, was penetrated, and then a layer of soft marly clay, about 10 inches thick. These clay layers occur about every 10 feet of rock. The rock was much harder as the shaft descended, and alternated red and white. The rock is not laid in horizontal layers, but is what well-sinkers call *Eddy-Rock;* and not all inclining one way, but crossing one another with great irregularity, and at various angles of descent."

Three of these pits have been formed in the memory of persons now living. The one marked *a* fell in about six or seven years ago. A clergyman, who happened to be near at the time, told me that he was standing by the river side with some boys watching two men, who were fishing, when they heard a noise like thunder; and looking round in the direction of the noise, they saw a mass of earth and stones rising into the air, and then falling down again. One of the men went near, and found that the rock had fallen in, and a pit had been formed about 30 feet in depth, at the bottom of which there was a quantity of water in a state of ebullition. The water continued in this agitated state during the following day, and afterwards gradually sunk. At present the pit is dry, and partially filled up by the falling in of one side.

Another pit, *b*, fell in about twenty-two years ago with a considerable noise, alarming the inmates of a neighbouring house, from which it is only separated by a road, but otherwise doing no harm. It is crater-like, having occurred beneath the gravel, and is now planted as an orchard. The pit marked *c*, mentioned above, fell in about forty years ago. It contains water, but in dry seasons this is nearly all drained away, and the rock is laid bare at the bottom.

These pits are also of frequent occurrence in the parish of Hutton Conyers; there are several in Sharrow, and one in Bishop Monkton, three miles south of Ripon, which was formed between thirty and forty years ago, near the Old Hall. Some men had been engaged in making a stack, and had left it for some purpose, when suddenly the ground gave way beneath the stack, and it disappeared. The place still exists, a receptacle for rubbish.

Perhaps some of the readers of the GEOLOGICAL MAGAZINE will be able throw a little light upon the manner in which these singular pits have been probably formed.

NOTICES OF MEMOIRS.

ON *LESKIA MIRABILIS* (Gray). By Prof. S. LOVÉN.

Communicated by Dr. CHRISTIAN LÜTKEN, Assistant Zoologist in the Museum of the University, Copenhagen.

THIS little paper, inserted in the "Proceedings of the Royal Swedish Academy" for 1867, well deserves the attention of palæontologists, though its principal aim is to re-describe a little-known *recent* Sea-Urchin from the Eastern Seas, because this animal throws a peculiar light on certain important points in the morphology of *Cystidea.* It is, moreover, distinguished by all the ingenuity, accuracy, and profound knowledge which is peculiar to the works of the celebrated Scandinavian zoologist.

The genus *Leskia* is described, in 1851, by Dr. J. E. Gray, in the "Annals," and subsequently, in 1855, in the "Catalogue of Recent Echinida," from specimens from Lugard, in Mr. Cummings' collection. It is most intimately allied to the *Spatangidæ*, of which it has the general stamp, but is distinguished from them, and therefore the type of a peculiar family (*Leskiadæ* Gray) or tribe (*Palæostomata* Lovēn) by the peristome and periproct being closed up with a few "triangular converging valves," those of the vent with some small "spicula" in the centre. Dr. Gray has already remarked that "in the form of the mouth and vent it has considerable affinity with the fossil *Cystidea*, especially the genus *Echinosphærites*." The detailed description given by Prof. Löven quite confirms this remarkable combination of features; the characters assigned to the "*Palæostomata*" are as follows: *testa oviformis, peristomium non labiatum, pentagonum, æquilaterale, ore quinqueralis, anus intra periprostium centralis, valvis clansur quinque-octo; aperturæ genitales binæ; semita unica peripetala.*" *Leskia* is a true Spatangoid, *save the mouth and the vent;* the latter, instead of being surrounded by a threefold circle of minute plates, the greater and outermost, has only 5, 7, or 8 great triangular outer plates, and an equal number of minute inner papillæ. The peristome is not bilabiate with a prominent under-lip, nor is it formed principally by the ambulacral plates; it is *pentagonal*, and bordered almost exclusively by the interambulacralia; there is no buccal membrane covered with three to five series of irregular plates, decreasing inwards, but the mouth is closed up by five equal triangular plates, inserted on the five sides of the peristome. "No living Echinid has such a mouth;" but the author thinks that the genus *Toxaster* of the "Neocromien Inférieur," whose peristome was pentangular, not labiate might possibly—though the configuration of its mouth somewhat more approaches to that of the true *Spatangidæ*—have had a similar organization.

In the Silurian *Cystidea* again, we find precisely the same structure as in the recent East Indian Sea-urchin, viz., in the commonly so-termed "ovarian pyramid," which, after the opinions of Gyllenhal, Wallenberg, Pander, Hisinger, de Koninck, and Billings, is really the mouth, whilst von Buch, with some inconsequence, makes it the mouth of *Caryocrinus*, but the genital outlet in the other *Cystidea*, and Joh. Müller and Volborth sought the mouth in the centre of the converging ambulacral furrows. The remarkable observations on *Sphæronites pomum* and *Echinoychærites aurantium*, by means of which Prof. Löven draws the conclusion that *Leskia is a Spatangoid with the mouth of a Cystidean*, we will give with his own words.

"Good specimens of *Sphæronites pomum* Gyll., collected by Prof. Angelin, show its organization more distinctly than usual. He had observed that this animal had *no stalk*, but adhered immediately to rocks or other objects through a part of its lower surface, which is without pores, and surrounded by a ridge formed of the somewhat thickened, free, smooth border of the undermost plates. This surface of attachment is of a very variable form and extension in different specimens,—round and but little excavated in some, oblong and deep in others,—depending upon the nature of the object to which it adhered. On the point opposite to this basal surface lies the apex with the ambulacral apparatus. In the middle a somewhat deepened area *d*, through which five delicate but distinct ambulacral furrows pass towards five arms, whose bases form a circle, which however is broken at *i*, one-fifth of its circumference. Where the furrows reach the arms, they will be seen to pass into an oblong hole *e*, which is the lumen of the broken furrow of the lost arm; in every remaining arm-base you will see an indication of the branching of the arms and of the central channels of the branches. Close up to the ambulacral circle lies the "pyramid" or mouth *a*, closed by its five valves of unequal dimensions, two of them are emarginate on one side in order to give space to the two adjoining outermost arms, which are less than the others, and, as it were, crippled, the right by its vicinity to an oral valve, the left by an apparatus *b*, that cannot be interpreted otherwise than as an external genital organ. When it is tolerably well preserved, it is conical, with a rounded apex, without any terminal aperture; for vestiges of valves I have sought in vain, but in two specimens I found the two pores indicated in the figure. From this organ a ridge *c* runs towards the next arm, suggesting the idea of the possible existence of a "madreporite." The centre of the brachial apparatus forms with the genital organ, and the oral orifice a compressed but only slightly inequilateral triangle. In *Echinosphærites aurantium* the relative position of these parts is the same, but the triangle, which they form with each other, is much larger, longer, and more inequilateral, because the distances are greater, especially that of the mouth from the ambulacral apparatus, which is correctly described and delineated by Volborth and Joh. Müller. Close to this is seen the other "orifice," viz., the external genital organ. All specimens that I have examined have this so-termed "orifice" in such a condition that it most likely is the remnant of a prominent broken part, and it must be assumed that in this species also it had a conical form, but remained mainly in the surrounding stone-matrix. Volborth's figure (Ueber die Russischen Sphæroniten, x. ix. f. 9) appears to be correct, but gives no complete evidence as to the presence of the three valves." That the "pyramid," which in *Leskia* is the armature and covering of the mouth, is the same thing in *Cystidea*, is now quite certain; in the last-named group it was, doubtless, also the vent. The mouth does not lie where J. Müller and Volborth sought for it, viz., in the centre of the ambulacral furrows; and the organ, interpreted as the vent by Volborth and von Buch, is more correctly regarded as an external sexual organ."

It is not my intention to criticise the various interpretations of the morphology of *Cystidea* given by different authors, or to trespass on the space here allowed me by a detailed examination of all the questions entangled with them. But should I venture to express any humble opinion of my own on this important point in the morphology of *Echinodermata*, I must first confess that *hitherto* I have been very sceptical as to the theory advocated so very ingeniously by Mr. Billings and now upheld by Mr. Lovën. The concordance between these two authorities is nevertheless not so great as would be supposed—that the "pyramid" was the mouth of the *Cystidea*, and that this orifice accordingly would lie elsewhere than in the centre of the ambulacral system, where it lies in *all living* Echinoderms and (I may add, where it did lie, I have no doubt, also in the Palæozoic Crinoids, where no superficial ambulacral channels are to be seen, but where they pursued their way on the *inferior* surface of the "vault" through the "ambulacral orifices" at the base of the arms,—as shown by Mr. Billings, with whose researches [see Decades Geol. Survey of Canada] I was, I regret, unacquainted when I wrote my paper on *Pentacrinus*, etc.) I know no other exception to this rule, and would it not be a dangerous thing—not be done without very strong arguments—to give up the leading principle of Palæontology, viz., that only from the organization of the *living* form can we learn to understand that of the *extinct?* Might we not thus too often run the risk of giving up ourselves to the delusions of fancy. When we remember how minute and concealed the mouth often is in *recent* Crinoids, we should not be puzzled at its being almost or quite invisible in *fossils;* and if we should search for the interpretation of an orifice, closed by a definite low number of triangular valves, will not several recent *Echinidæ* (*Echinocidaris*, *Echinometra arbacia; Leskia* itself.) give us the answer, that such an aperture *could* (at least) be a *vent?* Nor can I well conceive that an aperture should altogether fail to exist in the centre of the ambulacral system of *Cystidea*. How otherwise could the ambulacral vessels communicate with the interior? And if such an orifice *must* be assumed (though it be often obliterated and hidden in the fossils), why should not this "apical" or "ambulacral orifice" be also the mouth as in *Asteridæ* and recent *Crinoids*, and the valvular orifice be the vent, analogous to the "proboscis" of the Palæolithic Crinoids[1] or the "oral tube" of the living? The superiority of size of the presumed mouth is not, as Mr. Billings thinks, a very good argument. Has not the oral tube in many of our recent Crinoids (*Anteden*, *Actinometra*, *Pentacrinus*) the same preponderance over the minute buccal orifice? Nor has the repeated revision of the published descriptions of other *Cystidea*, accessible to me, convinced me of the correctness of a theory. according to which the mouth would, in many instances, lie very far from the arms, sometimes nearer to the base (the stalk or point of attachment) than to the apex of the calyx. The argument deduced in later times from the presumed existence of five similar peristomatic valves in the recent *Pentacrini*, I have elsewhere had the opportunity of refuting[2]; no such hard "clapets" are to be seen in *P. Mülleri*, and until their

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[1] The analogy between the valvular aperture of *Caryocrinus* and the "proboscis" of Crinoids is also argued by Mr. Billings (Dec. No. p. 14.

[2] Om Vestindiens Pentacinen, p. 205 (Vidempel. Meddel. f. d. Naturhist Forening, *1864).*

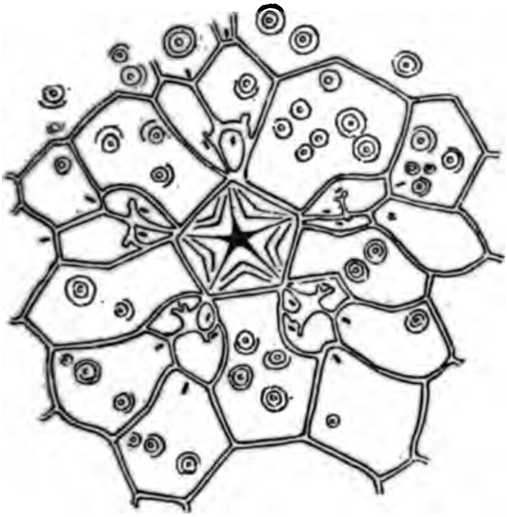

Fig. 1.

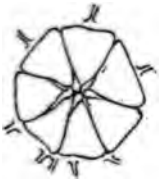

Fig. 2

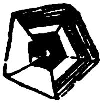

Fig. 3.

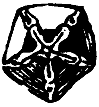

Fig. 4.

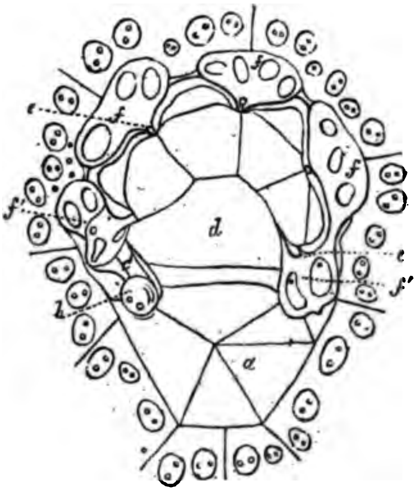

Fig. 5.

Fig. 1. Mouth, and adjoining parts of *Leskia mirabilis*, Gray. Fig. 2. Vent of the same. Figs. 3. and 4. The mouth of *Echinosphærites aurantium*, Gyll. Fig. 5. The apex of *Sphæronites pomum*, Gyll. (*a*.) The mouth. (*b*.) The genital process. (*c*.) Its ridge. (*d*.) The ambulacral area with its furrows. (*e*.) The lumen of the furrows. (*f*.) The base of the five arms.

existence is *proved* in other recent *Pentacrini*, I must doubt, or rather deny, their existence at all![1] On the other hand, I must confess that matters are considerably altered by these highly valuable investigations of Prof. Lovën, who, for the first time, supports this theory with strong (perhaps convincing) arguments. It is *now* no longer a mere hypothetical supposition—hitherto it was in reality no more—but a real scientific explanation, borne out by well-established facts and undeniable analogies from living forms.[2] To Dr. Gray we certainly owe the first intimation of this analogy between *Leskia* and *Cystidea*, but while the knowledge of that genus rested on a single examination, there might still linger some doubt whether its importance in this respect had not possibly been overrated. Science, therefore, must be highly indebted to Prof. Löven for his small but valuable memoir, and for the excellent observations laid down in it. The absolute denying of the existence of an apical orifice in that place where, in other *Cystidea* at least, such an orifice was always believed to exist, is particularly recommended to the attention of future investigators of *Cystidea*, as bearing upon the very heart of the question. *Adhuc sub judice lissit!*

[NOTE.—For a very able account of the internal structure and passages in *Actinocrinus, Amphoracrinus, Cyathocrinus, Rhodocrinus, Pentremites*, and *Codonaster*, see Memoir, by John Rofe, Esq., F.G.S., in GEOL. MAG., Vol. II. p. 245, Plate VIII. 1865.]—H. W.

NEW AMERICAN FOSSIL FISH FROM THE DEVONIAN.

(Communicated by Professor C. H. HITCHCOCK, of Lafayette College, Geologist to the State of Maine, etc.)

AT the late meeting of the American Association for the Advancement of Science, Professor J. S. Newberry, LL.D., described a new genus of fossil fishes. The specimens were obtained from the Devonian Black shales of Delaware, Ohio, by the Rev. H. Herzer, and named *Dinichthys Herzeri*, inasmuch as the animal deserved the same distinction among fishes as the *Dinotherium* and *Dinornis* among mammals and birds. Most of the bones obtained belong to the head, which was over three feet long by one and a half broad, and wonderfully strong and massive. All parts of the head were represented, and there were several individuals among the specimens. The cranium is composed of a number of plates firmly anchylosed together, and strengthened near the occiput by internal ribs or ridges nearly as large as one's arm. The external surface is covered with a very fine vermicular ornamentation. The most marked peculiarity in the anatomical structure relates to the form and texture of the jaws and teeth, best understood by the annexed figures.

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[1] Prof. Lovën told me himself that during his last stay in Paris he succeeded in getting access to the original specimen of Mr. Dushascaing, in the collection of the late Mr. Michelin. It did not show the five valves, because it had no peristome at all!

[2] *To these analogies might be added, that between the valves of Cystidea and those of the young (larval) Antedon.*

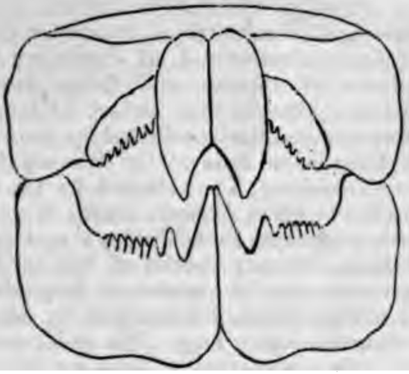

Fig. 1. Anterior aspect of head of *Dinichthys Herzeri*, one-eighth nat. size.

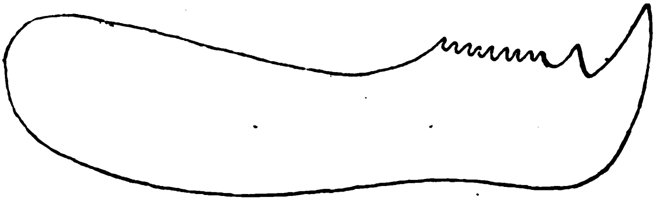

Fig. 2. Mandible of *Dinichthys Herzeri*, one-eighth nat. size.

The head terminated anteriorly and above in two great incisors, representing the premaxillary, behind which on either side are the maxillaries, broad, flattened, dense bones, along the lower edge of which is set one row of small robust teeth, formed by the consolidation and prolongation of the jaw-tissue. The mandibles are over two feet long by six inches deep, laterally flattened and very massive. The anterior extremity was turned up in a huge triangular tooth composed of dense ivory-like tissue, which locked in with the divergent incisors of the upper jaw. Behind this, in some specimens, is another triangular summit, and posterior to it a row of small teeth, corresponding with those of the maxillaries. Such was the power of this tremendous dental apparatus, that the bodies of our largest living fishes would be instantly pierced and crushed by it, if exposed to its action. Behind the head are large thick plates, one of them corresponding to the *os medium dorsi* of the *Heterosteus* of Pander, and being at least of equal size. These bones occur exclusively in concretions.

III—.NEW CARBONIFEROUS REPTILES AND FISHES FROM OHIO, KENTUCKY, AND ILLINOIS.

(Communicated by Professor C. H. HITCHCOCK, of Lafayette College; Geologist to to the State of Maine, etc.)

AT the late meeting of the American Association for the advancement of Science, Professor J. S. Newberry exhibited and described specimens of reptiles and fishes from the Cannel stratum beneath the principal coal bed at Linton, Ohio; fishes from the Coal Measures of Illinois, collected by the State Geologist; and fishes from bituminous shale in the *Waverly group*, 125 feet above its base at Vanceburg, Ky., collected by Dr. Patterson. Of these the first series included *Raniceps Lyelli*, Wyman, and others undescribed, partly related to Prof. Huxley's new genera *Ophiderpeton* and *Urocordylus*. Twenty species of fish accompanied these reptiles, among which are eight species of *Eurylepis*, Newb., small Lepidoids allied to *Palæoniscus*, distinguished by having the scales of the sides much broader than long. The scales on several of the species are very highly ornamented. These specimens were *gilded* by iron pyrites. Some specimens of *Cœlacanthus*—two species—indicated the presence of a supplementary caudal fin, as in *Undina*.

This is an interesting fact, confirmatory of Huxley's view of the relations of *Undina*, *Macropoma*, and *Cœlacanthus*. The numerous and very complete specimens of *Cœlacanthus*, exhibited supply much that was wanting to a perfect knowledge of the anatomy of the genus. The bones of the head are similar in form to those of *Macropoma*, highly ornamented with tubercles above and thread-like lines below. The jugular plates are double, and oblong-elliptical in outline, as in *Undina* and *Macropoma*. The position and form of the fins is the same as in *Undina*, but the anterior dorsal is stronger. The fins are supported on palmated interspinous bones, similar to those of the other genera of the family. The paired fins are slightly lobed; the supplemental caudal has been referred to. The scales are ornamented with curved and converging raised lines. In many specimens the otolites are distinctly visible.

Besides the fishes found at Linton already enumerated, there are scales and teeth of two species of *Rhizodus*—one at least of which (*R. angustus*) has teeth of two forms, the one large and flattened, the other smaller, more numerous, slender, striated, and conical, with a circular section throughout: two species of *Diplodus*, consisting of bony base and enamelled crown, the latter distinctly and beautifully serrated—so that there can scarcely be a question that they were teeth, and not as claimed by Mr. Atthey, of Newcastle, England, to be dermal tubercles. There are also examples of *Palæoniscus scutigerus*, Newb., one species of *Pygopterus*, one of *Megalichthys* represented by scales, and numerous species of placoid fishes of the genera *Compsacanthus* and *Pleuracanthus*.

The fish remains from Illinois consisted of a splendid specimen of *Edestes vorax*, Leidy, from the coal at Belleville, opposite St. Louis, and of several individuals of a new species of *Platysomus* from Mason ek. The *Edestes* is allied to a fine specimen from Indiana, figured wen's Palæontology, p. 124, 2nd ed., and there properly referred he spine of a Plagiostome. *Platysomus* has not been found in erica before.

he fish remains from the Waverly sandstone are from a new izon, having furnished a single species in Northern Ohio, *Palæo- us Brainerdi.* The new specimens consist of teeth of *Cladodus* *Orodus*, with spines of *Ctenacanthus*, and the tail of one of these ichians distinctly preserved. This is a great rarity, as the soft even the cartilaginous parts of plagiostomous fishes are usually omposed, leaving only the detached teeth, spines, and dermal ercles. The only other similar cases known to the author, are the and fins of a *Chondrosteus* from the Lias of Lyme Regis, and the servation of the form of *Thydina* in the Solenhofen slates. These cimens are from the base of the Carboniferous series, and therefore ch older than the European examples. This tail is very heterocercal. the caudal fin of some living sharks, and indicates an animal en or eight feet long. The author hopes to be able to gather from collection the data for uniting many teeth and spines, now cribed as distinct genera, into the same species.

REVIEWS.

CHERCHES GÉOLOGIQUES DANS LES PARTIES DE LA SAVOIE, DU PIÉMONT ET DE LA SUISSE VOISINES DU MONT-BLANC. Avec n Atlas de 32 Planches. Par ALPHONSE FAVRE, Professeur de Géologie à l'Académie de Genève. Paris, Victor Masson, 1867.

HIS work, by M. Alphonse Favre, upon the geological structure of the mountains and valleys surrounding Mont Blanc, consists three volumes, containing in all 1,488 pages, and is the result of labours of a large portion of the life of a praiseworthy follower his distinguished countryman de Saussure, and is a full illustration his previously published remarkable Geological Map of this ion. By exhibiting numerous features and structural details in tions, and other illustrations of the physical relations of the rocks, l by bringing to bear on them those lights of palæontology, which re unknown to de Saussure, and in which his contemporaries and ntrymen Pictet and Loriol have been so distinguished, he has tly extended and improved the original sketch by his great ster.

Any geologist, who, leaving for the first time the shores of Lake man, may have attempted to reduce to anything approaching ssified order the various broken rock-masses which surround Mont inc, must have found, to his discomfiture, that they were composed countless fragments of different sorts, thus presenting a confused emblage, which seemed to defy methodical arrangement. But, th time and patience, and through a succession of researches in eastern parts of the great chain where the natural formations, particularly the older, are more expanded, and have been less subjected to disturbances and change, the time has now come, when even this, the most complicated tract of the whole chain, is to a great extent laid open with clearness.

The Alps, as a whole, have only in truth been brought into a true geological order of succession by a long series of patient investigations, particularly during the last forty years, as carried out by a number of hard-working geologists, of all countries; and M. Favre has now accomplished for his portion of the chain that which Professor Studer has more particularly elaborated for the great central or Swiss masses of the range.

In the last century the chain of Mont Blanc, with its flanks, was viewed as of primitive age, and this error has been dispelled by the successive labours of numerous explorers. Among these Brochant led the way in 1808 in his able work on the Tarentaise, wherein he showed that a great part of the supposed primary rocks were of Neptunian or sedimentary origin, including rocks of Carboniferous and Liassic age; and, long after M. Elie de Beaumont, extending his excellent Geological Map of France into Savoy, showed the vast extension of the Liassic deposits.

In correlating the *disjecta membra* of the chain of the Alps as a whole with their true equivalents in less disturbed regions of the globe, our countrymen have also played a fair part. In 1820, Buckland, after a summer's tour, boldly dashed off his general views as to the great "Alpine Limestone," representing in its range most of the Secondary rocks; and though necessarily very incomplete, these generalisations were at the time striking evidences of the power of that eminent geologist.[1]

But of all the earlier English writers on the structure of the Alps, no one threw so much light on the Savoyard portion of the region as Bakewell. In his "Travels in the Tarentaise" (1820–22), this author not only instituted comparisons with known British formations, but he clearly showed that chemical changes took place on a stupendous scale by the transmutation of mountain masses of stratified limestone into gypsum and dolomites.

In 1827, Murchison hit off an exact definition, which remains correct to the present day, by showing on the southern flanks of the Alps, north of Bassano, the existence of a regular order of succession from the massive Oolitic or Jurassic rocks of the chain through the Cretaceous, the latter being symmetrically flanked by the Nummulitic and younger Tertiary deposits of the north of Italy.

In the meantime, struggling with considerable difficulties, Boué had been constructing maps and descriptions of large portions of the Austrian Alps, which, considering the want of good geographical materials, did that indefatigable geologist infinite credit.[2] Sedgwick and Murchison explored together a large portion of those same Austrian Alps in 1829, and were so far successful, whilst disputing (not always with justice) some of the conclusions of Boué, as to reduce to symmetrical order a large tract of the Secondary rocks north of and around Salzburg, and to exhibit in regular order the succession of the Secondary and Tertiary rocks in their easternmost extremity, where the Alps die away into the plains of Styria.[1]

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[1] Annals of Philosophy.

[2] Boué was the first to publish a geological map of Scotland, anno 1820.

From such efforts, and particularly from the excellent researches of Leopold von Buch, Boué, Studer, and others which followed, the true order was gradually extended to the more complicated region of the west, in several parts of which, where complicated crystalline rocks—whether igneous or metamorphic—most abound, other distinguished German geologists besides von Buch had been for many years occupied.

Among the French geologists, no one had more distinguished himself tham M. Élie de Beaumont in elaborating the effects of the great intrusions of granitic and other igneous rocks in the Western Alps, and in explaining the abnormal position into which the original deposits had been thrown. In the same way von Buch, who wandered during many a year, on foot, through all the recesses of the Alps, has, in his maps and writings left behind him frequent proofs of the effects produced by granites and porphyries upon the sedimentary deposits which they have invaded.[2]

But to no school of geologists who have been working out the original symmetry of the Eastern Alps have we been more indebted of late years than to the Austrians, who have succeeded in assigning to some of the great central calcareous masses of the chain their places in the geological series much more exactly than was previously known, and to delineate them in detailed and well finished maps, published under the direction of the Imperial Royal Geological Institute, presided over by its veteran leader, Haidinger.[3] The clear proofs of the existence of the Trias, and its calcareous centre, the Muschelkalk, though long ago indicated by von Buch, is one of the great recent trophies of those Austrian geologists.

But passing from this rapid glance at the methods by which a general acquaintance with the structure of the whole chain has been attained, we return to the consideration of the mountains and valleys around Mont Blanc. It is this region, so broken and so complicated, and which seemed to baffle the industry of that accurate mineralogical geologist, Necker de Saussure, which M. Alphonse Favre has described; and his task, we are bound to say, has been accomplished in a masterly manner.[1] As it was said of de Saussure, who first grappled with the physical obscurities of this region, that "he was one of the men privileged by Providence to trace the road to new conquests," so we may say of his countryman and successor, Alphonse Favre, that in following his great master he has wrested from this complex region many important revelations unknown to his predecessors. To take one striking example of his successes, nothing can be more creditable to him than the clear and skilful explanations and diagrams with which he has taken a leading part in clearing up the long mooted question as to whether or no the fossil plants of the old Carboniferous period, in Haute-Maurienne, and at Petit Cœur in Savoy, lived on to the age of the Lias; it being now generally admitted that the strata of these two widely different formations, having been accidentally collocated, have been so twisted up by convolutions as to appear to belong to one and the same geological mass.[2]

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[1] The Geological Map of the Eastern Alps (Trans. Geol. Soc. 2nd Series, vol. iii. p. 35) which comprised the result of these and other researches, was executed by Murchison after the labour of three summers. It exhibited the real order of succession then known (1831), from the axial and oldest rocks to the secondary and tertiary deposits on either flank of the chain. See 2nd ser., vol. iii., pl. 35, in the Trans. Geol. Soc., with description thereof. See Sedgwick's explanatory preamble.

[2] See particularly the Maps of the Alps published by Martin Schropp & Co., Berlin, which are essentially the results of the labours of von Buch.

[3] To obtain a just appreciation of the value of the labours of the Austrian geologists, it is only necessary to inspect the sheet (No 6) of the remarkable general Map of the Austrian Monarchy, by Herr k. k. Director, Dr. Franz Ritter von Hauer, in which the various rocks of the Tyrolese, Milanese, and Venetian Alps are defined by 48 distinct colours and signs.

On the other hand, the candour with which the author acknowledges a mistake in his earlier researches, by which he placed a Secondary limestone above the Nummulitic rocks, is so ingenuous, that we quote the passage as a valuable reminder to all working geologists, who well know that during their career they will have to acknowledge many such an error. "Mais ce qui me console (says he) d'être classé parmi ceux que les terrains des Alpes ont entrainé à faire certaines confusions, c'est la nombreuse et bonne société dans laquelle je me trouve" (vol. ii. p. 33). So numerous, indeed, are the points of confusion, that no historian of the geological succession in the Alps can perform his task rightly and completely, if he has only viewed the complicated region so well examined by M. Favre. In it there do not exist any recognizable Palæozoic rocks of higher antiquity than the Carboniferous; and of these, portions only of clearly defined zones are to be here and there detected among the crystalline and metamorphic masses of the broken ridges. It is a region, in short, without any recognizable fundamental rocks; the lowest and axial masses being disguised by heat and change. Hence it follows that if in the Central, and particularly in the Eastern and Central Alps, the disarranged strata had not been reduced to order, and the real Palæozoic succession recognized, the geological history of the whole chain would have had no true beginning. In other words, had it not been already shown that in those Eastern Alps there existed Silurian, Devonian, and Carboniferous animal remains, the key to a true historical succession of the whole chain would not have been obtained. Yet, though the work in question deals with the most broken and complicated portion of the chain, the manner in which M. Favre has unravelled this record does him infinite credit.

M. Favre gives also a very complete summary of every contribution of knowledge by other authors to his favourite portion of the chain, from the days of de Saussure downwards; and all those who have contributed their notices among this multitude of observations have been carefully and honourably quoted.[1] Among English geologists, he cites Murchison, as having in company with M. Pillet discovered true fossiliferous Upper Chalk at Thones, east of the Lake of Annecy; and he gives indeed a section published in the Quarterly Journal of the Geological Society,[2] which our countryman dwelt upon, as one of the several proofs to establish the generalisation, that Chalk with characteristic fossils and wholly void of Nummulites rested on a series of the Lower Cretaceous rocks, and was regularly superposed by masses of Nummulitic Limestone; and followed by "Macigno Alpin," or "Flysch," which he also observed in more eastern ranges of the chain, as well as in the Apennines.

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[1] See also a just and highly favourable estimate of this work as given by Professor Studer, in Archives des Sciences Physiques et Naturelles, No. 121, Fevrier, 1868.

[2] In the opinion of the geologists of the Geological Society of France who visited this tract, the views of M. Favre were fully sustained; and the area of observation considerably extended.—See Bull. Geol. Soc. de France, vol. xxii. p. 59, 1864-5.

In parts of the region north of Mont Blanc the Secondary rocks have been here and there developed (particularly at Mont Salève), and M. Favre disentangles their various members from the breaks and contortions to which they have been subjected, and so assigns to each the fossil remains by which they are recognised, that we feel we are following a skilful pilot through a devious labyrinth. As regards these Western Alps, no organic remains have been found beneath the Lias except numerous plants of the palæozoic Carboniferous era. For, although M. Favre applies the term of "Trias" to a great thickness of crystalline and sub-crystalline rocks which lie between the Lias and the Carboniferous, these strata have not as yet afforded any of those fossils which in the Eastern Alps so clearly characterize the Trias with its numerous Muschelkelk remains.

The English reader will find the divisions of the strata, from the upper portion above the Oolitic series ("Oölite Corallienne"), described under the Cretaceous divisions of Valangian, Neocomian, Urgonian, or Lower Greensand, their fossils being well defined and figured by M. Loriol and the author. It has been long since ascertained that these Cretaceous deposits, including those of Gosau, which abound so greatly in the more eastern parts of the Alps, and are particularly distinguished by large Nerineæ, Tornatellæ, the Diceras, and shells of a Cerithium form, belong really to the Cretaceous group, though nearly forty years ago they were at first referred to a supra-Cretaceous age,[3]—an opinion, however, which was long ago abandoned. In a word, we commend this work of M. Favre as entitled to a place of honour in all scientific libraries, if only to show the vast difficulties which have been overcome in bringing great masses of such varied lithological character into anything like a regular classification.

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[1] In proof of the assiduous labour with which M. Favre has ransacked every scrap of writing respecting this Alpine region, it may be stated that, in his history of the Carboniferous rocks, he refers, in one long chapter thereon, to eighty authorities who have published on the subject; and, of English geologists, he cites the names of Bakewell, Buckland, Buckman, Bunbury, De la Beche, James Forbes, W. Hamilton, L. Horner, Lyell, Murchison, Playfair, &c.

[2] Vol. v., p. 186. In this work Sir R. Murchison expresses his deep obligations to Canon Chamousset, of Chambery, as well as to M. Pillet, for the accurate knowledge he obtained in company with them.

[3] See Sedgwick and Murchison, Trans. Geol. Soc. 2nd Series, vol. iii. p. 301.

Yet, after all, the author candidly indicates how much still remains to be done before every mass of the Western Alps can be assigned with precision to its normal equivalent in the undisturbed regions of the world. Thus, his inferences as to the age of the supposed oldest stratified rock, the Protogine of Mont Blanc, are of an enquiring rather than a conclusive character. Many pages are, indeed, devoted to the development of his theoretical views of granite having been formed in an aqueous manner, though, in adopting this view, he admits that granite was a decomposed subterranean lava; and as sub-aerial lavas also contain water, we do not appreciate the value of this subtle distinction. But apart from this theory, when he states his belief, that granites were formed in this wise during very early or ante-palæozoic eras, his hypothesis seems untenable when we consider the conflicting evidences with which this troubled region abounds, and wherein no true sedimentary rock, as proved by infraposition and fossils, is older than the Carboniferous era. It is a region, we repeat, void of a recognizable base,—the Laurentian, Cambrian, Silurian, and Devonian rocks, and even the Carboniferous limestone, having here no representatives with fossil animal remains; and believing that the granitiform and porphyritic rocks of the Alps are, geologically speaking, of no high antiquity, we demur to the assumption that they can be connected with earlier geological times.

If we follow the author along his mountain walks among the highest Alps of Maurienne and the little Saint Bernard, and see how he recognizes the complete overthrow of formations of great dimensions, in so crystalline a state, we see that the distinction between what used to be known as igneous and aqueous rocks is in many places almost evanescent. For, whether we side with him or not in his belief in the sedimentary origin of many of these quasi-stratified granitiform masses, we have before us sufficient proofs of disturbance to account for the grand fan-shaped arrangements and convolutions involving great overthrows, which he describes, to say nothing of the stupendous rents and fractures which abound in this tract.

Even when he is treating of his only really recognizable fundamental formation in these Western Alps,—the strata containing old coal plants,—we see how this formation is irregularly followed by distinct superincumbent secondary formations in different parts of the chain. Thus, the so-called "Trias" is nowhere characterized as in the Eastern Alps, by possessing its true central Muschelkalk fossils. On the contrary, it is composed of highly schistose and crystalline masses with gypsum and dolomitic limestone. And, as if to render the confusion greater, in a vast portion of this western chain, particularly in the Maurienne and Savoy, even this equivalent of the Trias is wanting; and the Lias and Jurassic rocks, with their fossils, are not only placed at once in contact with the Carboniferous rocks, but the two are convoluted in so many rapid plications, that eminent geologists have been unable to dissever them stratigraphically. Nay, we even there see the Nummulitic rocks, which in parts of the chain are clearly superimposed upon fossiliferous Chalk, pass under all these older rocks, whether Secondary or Carboniferous!

Now, one of the great merits of M. Favre is, that he has patiently and diligently followed out many of such folds and inversions in the heart of these mountains, and has been able to assign to them their relative places; but still there are many lofty portions of the chain respecting which great uncertainty still exists as to the relative age of some rocks which most geologists consider to be metamorphic.

In conclusion, we recommend the work of M. Favre as a capital study for those nimble climbers of the higher parts of the chain, who, ignoring nearly everything but the superficial accumulations of snow, ice, and glaciers, go aloft to catch light and shadows, air-effects, and cloud-views. Without such preliminary study they can have little or no conception of the physical and mental toil which the geologist has undergone in unravelling the complicated strata of which the peaked, the gnarled, and the rounded mountain-masses are respectively formed —complications, indeed, repeated in breaks, twistings, and crumplings, most of which were successively brought about in ages long before a flake of snow fell upon the rising Alps. And upon this point, too, the glacierist, as well as the geologist, will find in the first volume of M. Favre's book many excellent and original data illustrative of the more recent periods at which the glaciers have shot off much detrital matter, and of the relations of such *dêbris* to the existing valleys and river-courses.

No one can doubt that the snows and glaciers of the Alps, in melting and moving since the earliest glacial period, have deepened valleys on highly inclined planes, have lowered peaks and abraded surfaces of considerable magnitude. But he who, exaggerating the power of these comparatively recent causes, says, in his atmospheric and glacierist pride, that they have carved out the great valleys and have determined the main outlines of the chain, overlooks the indubitable effects of the grand subterranean forces which truly gave in very early ages a leading impress to the broadly marked features of mountain and valley—features which, however since modified by atmospheric agencies, have never been obliterated, and which are as eternal as the snows and glaciers of the Alps are, in a broad geological sense, casual and ephemeral.[1]

In short, the glacierist who has not worked out the evidences of these great subterranean changes, and reasons upon present forms and outlines of nature, must first learn his lesson respecting internal and original structures, before he can pretend to reason on this broad and complicated question. To all such persons we commend the study of this work of M. Favre, and its numerous illustrative diagrams. For he shows clearly, that the great valleys and lake basins are greatly due to original geological impress. Adopting this view, he has ably refuted the theory, that the depression of the Lake of Geneva could have been due to erosion by ice, that cavity having been a necessary and confluent depression accompanying the great contiguous upheaval of the central mountains, as indicated by de Saussure.[1]

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[1] It is in the first volume of the work of M. Favre, that the reader will find how he eliminates from each other the various superficial deposits, beginning with what he calls the accumulations of the plain and the deposits of the Rhone and its leading affluents. He then describes the Quaternary Deposits, consisting of recent alluvium, terrace deposits with remains of extinct animals, glacier detritus, and still older marine deposits, with lignite.

Nothing indeed can more strongly support the original view of that great man, as worked out by Favre, that the main outlines of the Alps are due to subterranean influence, than the following aphorism or law of Studer, derived from a life-long study of his native country, Switzerland, and which M. Favre puts in these words:—

"Toutes les fois que les couches en forme de C ont le dos tourné aux Alpes, les couches anciennes sont à l'extérieur et les couches modernes à l'intérieur, et réciproquement, toutes les fois que les couches en forme de C ont le dos tourné en dehors des Alpes, les couches anciennes sont à l'intérieur et les couches modernes à l'extérieur." (Vol. ii.)

The question of the greater or less permanency of the older external features of the earth, as due to subterranean geological action, has indeed been recently brought into discussion among British geologists by an appeal to the stratified crystalline rocks of the Central and Western Highlands of Scotland by the Duke of Argyll. On this point, however, it may at once be observed, that no two regions of the earth present greater differences in lithological and geological structure than the Highlands of Scotland and the Alps. In the former, the great and central mass consists of Lower Silurian rocks, for the most part crystallized, and occupying highly inclined and convoluted positions, they rest quite unconformably on the older Cambrian and Laurentian rocks of the west coast, the latter having, indeed, an entirely divergent direction to the others.[2] Now all the old crystalline rocks of the great central region are uncovered by any Secondary or Tertiary rocks, or indeed by any trace of their former existence; such deposits being only known to have occurred on the centre and western flanks of this primeval chain. In the Western Alps, on the contrary, as has been shown, no recognizable Palæozoic rocks exist below the Carboniferous, and these are surmounted by a variety of Secondary and Tertiary deposits, some of which reach to the highest summits, and are often in a metamorphosed and crystalline state. Now, whilst the geologist has to ferret out amidst such varied rocks, the movements from beneath, which have given to the Alps their main configuration, it is the rocky simplicity of the Central Highlands, and the character and appearance of the ancient rocks there rising everywhere to the surface, which have led the able author of the "Reign of Law" to express his opinion, that when those metamorphosed and crystalline Lower Silurian rocks assumed their main outlines, they were in a folded, broken, hardened, and crystalline form; and that this aboriginal outline, remaining to a vast extent persistent to the present day, has given and still preserves to that country the chief features of its configuration; *i.e.*, its grand fiords and lakes, its main valleys, and its mountain ridges.

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[1] See M. Favre's letter thereon to Sir R. Murchison, Phil. Mag., March, 1865.

[2] See Siluria, 4th Edit. Frontispiece, Map, and pp. 24, 163.

This memoir was prepared to oppose the ingenious views of Mr. Archibald Geikie, in his attractive and highly popular work, the "Scenery of Scotland viewed in connection with Physical Geology." In it Mr. Geikie points out, that, as the troughs or barrier-shaped strata often constitute the summits of lofty mountains, and that as the deep valleys are often the seat of great axial lines, so it follows that vast masses of once intervening and connecting strata must have been removed by erosion. This great erosion he attributes to long-continued atmospheric agencies during countless ages, including the action of glaciers, and the melting of the great sheets of snow and ice which during the glacial period rendered Scotland a region like the modern Greenland.

But, leaving the theoretical questions of Scottish Geology to be worked out on their own merits, we know, as regards the Alps, that Studer, Favre, and indeed all those geologists from the days of de Saussure who have best studied the chain, are of opinion, that most of the deep depressions and Alpine lakes (which are either at right angles to, or parallel to the general direction of the rocks) are mainly due to former subterranean movements, though doubtlessly much modified in subsequent ages by atmospheric agencies, and particularly by the action of glaciers, snow, ice, and waters descending upon steep declivities.

When, therefore, we see how the consideration of the inner structure of the Alps has been passed over by some casual visitors, who seek to account for much of the main outlines of the earth by external agencies, and who have gone so far as even to refer to ice action the excavation of these deep cavities and lake basins, which to practical native geologists and other able and observant thinkers are manifestly due to older geological forces, we fall back on the exclamation of one of the sturdiest veterans among Alpine explorers, the late Leopold von Buch, who, when the extreme glacier doctrines were coming into fashion, and were tending to obliterrate the study of all that he considered to be true Geology, fell on his knees, and exclaimed—

"O sancte de Saussure, ora pro nobis!" R. I. M.

REPORTS AND PROCEEDINGS.

Geological Society of London.—February 5th, 1868.—1. "On the Geological Structure of Argyllshire." By His Grace the Duke of Argyll, K.T., D.C.L., F.R.S., F.G.S., etc.

The object of the paper was to set forth some of the author's reasons for not accepting the views propounded by Mr. Geikie in his "Scenery of Scotland viewed in connexion with Physical Geology." His Grace believes that, although the atmospheric agencies of waste have produced great modifications of the surface, the form of the hills and valleys has in the main been determined by the action of subterranean forces.

In illustration of his opposition to Mr. Geikie's theory, he described a supposed case of the formation of a valley by atmospheric agencies, observing that, if the crumplings of the strata have not affected the present surface, a subsequent submergence and a fresh unconformable deposition filling in all the inequalities must have ensued, and that these new deposits must have been again raised along different lines of elevation. Taking this new deposit to be the Old Red Sandstone, the author asks how it was removed, and points out difficulties in the way of supposing the removal to have been either by submergence or by subaëriel agencies.

His Grace then stated that Mr. Geikie admits that the agencies of erosion have been guided in their work by the prevailing strike of the strata, which strike is followed along the same line by the larger faults, and by the anticlinal and synclinal axes,—at least as regards the general trend. He then pointed out that in reality all the great physical features of Scotland take the same N.E. and S.W. direction. He therefore considered that Mr. Geikie had understated the case of the coincidence of certain physical features, and had entirely omitted all mention of others, such as the appearances of subsidence and dislocation to be observed in the Western Islands, and the relations existing between dislocated sedimentary strata and apparently intrusive rocks.

In supporting his argument by special facts, the Duke of Argyll endeavoured to show that the whole valley-system of Argyllshire may be accounted for either by faults, foldings, subsidences, or anticlinals, mentioning in particular that Loch Tyne occupies the bed of an enormous fault; that Loch Awe lies along the line of a great subsidence of the metamorphic slates, and that the gorge of the Brander Pass lies along the line of a great fracture connected with the subterranean movements which brought up the granites of Ben Cruachan; with many other instances of a like nature, in discussing which he especially demurred to Mr. Geikie's theory that the transverse valleys and gorges have been formed by two streams, each working backwards towards its own source, until the ridge which divided them was finally destroyed.

His Grace also remarked that the mineral condition of the granites at the time of the subterranean movements was such as would facilitate the transmission of earthquake waves; and the condition of the slates was such as necessitated fracture when those waves were propagated beneath them.

In conclusion, the author contested Mr. Geikie's statement of the symmetry of river-valleys and uniformity of mountain heights; and contrasted the philosophy of the older geologists with that of the advocates of subaërial denudation.

CORRESPONDENCE.

CYCLOPHYLLUM FUNGITES, Flem. sp.

Sir,—In your report of the Meeting of the Geological Society of Glasgow, December 12, 1867 (Geol. Mag. Vol. V. No. 3, p. 142), I find that Mr. John Young is made to assert that "Dr. Duncan's figures reveal no new points in the structure of this coral which were not already known, etc., etc." Mr. Young also appears to have stated that David Ure was the original discoverer of the genus in question, and that Professor M'Coy had clearly delineated the various parts constituting the internal organization of the coral. To these statements I must give my most unqualified contradiction.

It can be readily seen in David Ure's good old book that he believed the curved horn-shaped coral in question was one of the "class *Coralloides*," or "sub-marine plants," and that it grew with its broad calicular end downwards. He called the coral *Fungites*, but gave neither a generic nor a specific name to it.

Fleming classified the coral in the genus *Turbinolia*, and gave it the specific name *fungites*. All subsequent generic names should be followed by Fleming's specific name.

M'Coy described the coral, and a drawing of its anatomy appeared with the description in Sedgwick and M'Coy, Brit. Pal. Foss. 1855, plate 3C, figs. 5 and 5*a*. He named it *Clisiophyllum prolapsum*. He was neither justified in his genus nor in his change of the specific name. M'Coy neither drew nor saw what is so evident in the scores of sections which Mr. Thomson has prepared of the species of coral in question. M'Coy's drawings of *Clisiophyllum* show a solid lamellar columella in the axis of the corals he properly described as belonging to that genus, but there is no such structure in his *Clisiophyllum prolapsum*.

There is a columella in the *Fungites* of Ure, the *Turbinolia fungites* of Fleming, the *Clisiophyllum prolapsum* of M'Coy,—it is not a solid lamella, but a series of ascending processes which pass from the base to the depression at the bottom of the calice, which is surrounded by the coronet of internal septa.

Milne Edwards and Jules Haime separated the "fungites" from the genus *Clisiophyllum*, and their specimens were not sufficiently well preserved or cut to enable them to discover the arrangement of *the septa and columellary processes within the* endothecal tissue which separates the coral into inner and outer portions.

Mr. Thomson and I claim these as new points, and considering that septal and columellary structures are of paramount importance in recent corals, we have a right to esteem them worthy of the consideration of all who have the slightest possible knowledge concerning the anatomy and physiology of the Zoantharia.

P. Martin Duncan.

Lee, S.E., *March* 13, 1868.

THE TRIAS OF CHARNWOOD FOREST.

Sir,—The paper in your last number, on Charnwood Forest, by the late Professor Baden Powell, suggests my recording one or two facts relating to the disposition of the Red marls on the older rocks that I noticed when visiting the district with the British Association excursion in August, 1866.

Professor Powell observes, "that there are several localities where the New Red has undergone some disturbance since its deposition," and gives an engraving of the Swithland Slate Quarry in illustration, which does not, however, seem to support this view. In all the sections I examined, the dip appeared wholly independent of disturbance, and due to an irregular base line of deposit, an element which is often overlooked in estimating the extent of changes of inclination subsequent to deposition. The Red marls of Charnwood Forest dip away in every direction from the high ground of the older rocks towards the surrounding level plain; but I was much struck with the fact that the direction and amount of inclination seemed to be less related to the entire mass of the high ground than to its details of contour. In the section of Swithland Old Pit, given at page 119, the two masses of Red marls are represented dipping towards a gully intersecting the slate. A subsequent movement of the slate is not, however, required to account for this, and an examination of the beds *in situ* conclusively show that the details of inclination are directly related to the original surface-contour of the fundamental rock, a point which is faithfully represented in diagram No. 2 of Professor Jukes' memoir.[1] A similar arrangement is observable in a cutting of the Bristol and Exeter Railway near the Bourton Station,[2] where the Keuper beds rise and fall at considerable angles of inclination over some prominent bosses of Carboniferous Limestone, and had not the fundamental rock been visible, the sudden changes of dip might appear to have been the result of disturbance.

Another noticeable feature in Charnwood Forest is the relation of the areal outline of the Red marls to the surface contour of the older rocks rising above them; long winding tongues of the red beds running up into the ancient valleys of the high ground, the contour of the exposed portions of which is entirely in harmony with that of the bottoms of the valleys buried beneath the remnants of the later deposit. This affords a good illustration of the extreme antiquity of the surface contour and hill-and-valley system of the Palæozoic rocks; and whatever form of erosion may have determined this contour, it has evidently been very little modified by marine erosion during the submergences of the Trias and succeeding formations. In fact, the general surface contour of the high ground, and all the principal hills and valleys of Charnwood Forest were in existence before the period of the Trias, for remnants of the Red marls occupy the ancient lines of waterflow, and these do not appear to have been changed by subsequent disturbances.

GEORGE MAW.

BENTHALL HALL, BROSELEY, *March 6th*, 1868.

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[1] In Potter's History and Antiquities of Charnwood Forest.

[2] See Section, Fig. 2, page 443, GEOLOGICAL MAGAZINE, Vol. III., October, 1866.

BADEN POWELL AND CHARNWOOD FOREST.

SIR,—The posthumous paper in your March number, by Baden Powell, appears out of date. More than half of its material had appeared in print before it was written in 1859; and the few new points it contains have been told over and over again during the last decennary. But what I wanted especially to note was a correction of the opening statement in the article, "That the Geology of Charnwood Forest was first systematically investgated by Professors Sedgwick, Whewell, and Airy in 1833." Your readers will find in the Annals of Philosophy, Jan., 1824, an elaborate memoir, with a good geological map and woodcuts, by William Phillips and S. Luck Kent, "Observations on the Rocks of Mount Sorrel, Charnwood Forest, and Grooby." This memoir is 20 pages long, and excepting the antiquated nomenclature, is as sound in its principles, accurate in its details and classification of the rocks, as are any of the recent Memoirs of Charnwood Forest, the Geological Survey, Mr. Jukes, or the recently published memoir by Professor Ansted.

From another remark in Mr. Baden Powell's paper, anyone would suppose that the district of Charnwood Forest had been a neglected field, whereas for many years past, and remarkably so of late, the local geologists of Leicester, of whom I am proud to be one, have explored every yard of its area, and are well acquainted with every geological feature to be found about its rocks. Their labours may not find a place in the Quarterly Journal of the London Geological Society, but they are to be found in the memoirs and transactions of several local societies.

JOHN PLANT.

PEEL PARK, SALFORD,
5TH FEBRUARY, 1868.

CLASSIFICATION OF GRAPTOLITES.

SIR,—I must ask you for leave to say a few words in reply to Dr. Nicholson's in your last.

1. The Graptolites have been supposed to be related to the Ctenostomatous Polyzoa—the Ctenostomata have corneous polyparies like the Graptolites. Dr. Nicholson dismisses the question of their Ctenostomatous affinity, because the Polyzoa "as a rule" have Calcareous tests; a "summary" process indeed. Dr. Nicholson has yet to make the acquaintance of the Ctenostomata, for the "free and corneous Polyzoa," of whose existence he is "*perfectly* aware," are a novel group of real or imaginary animals very different from the fixed Polyzoa to which Busk gave the name.

2. Dr. Nicholson changed his views *after* I pointed out, in the GEOLOGICAL MAGAZINE, his errors, and his progress in knowledge followed step by step my corrections. Your readers will form their own estimate of that "honesty" which accepts these corrections and publishes them without acknowledgment.

3. I ventured to suggest that somehow Dr. Nicholson had confounded gonophore with gonotheca, but such an error was so gross and so fundamental, that I suggested it with diffidence. Now Dr.

Nicholson says plainly that he used "gonophore instead of gonotheca, to signify the external bell-shaped ovarian vesicle of the Sertulariadæ." He also quotes Greene[1] in support of his position, and triumphantly adds that his quotation is but one of many similar statements! Had he pursued his examination of Greene's Manual a little further, he would have found, at page 47, that in the Sertulariadæ "gonophores, protected by the gonotheca, are borne along the sides of the gonoblastidium." Ignorant of the difference between a "reproductive body" and an "ovarian vesicle," that is, between a gonophore and a gonotheca, and consequently of all the remarkable phenomena connected with the development of the Hydrozoa, of which these terms are the exponents, Dr. Nicholson has discanted before learned societies and to the readers of scientific journals, on the relation of an obscure group of fossils to recent animals from these organs of reproduction! I may as well here give the reason why I have come to the rescue of a set of animals in which I have long been greatly interested. More than two years ago, when Prof. Wyville Thompson, who had promised a monograph of them to the Palæontographical Society, pressed me to undertake it instead of him, I refused, because I had resolved to confine myself to botanical researches; and to this resolution I would have adhered had I not been constrained to rescue my old friends from the hands of a man who, from the first, appeared to me to be, as he has now declared himself, imperfectly acquainted alike with the fossils and their living representatives.

4, A perusal of the laws of scientific nomenclature (British Association or M. De Candolle's) will enlighten Dr. Nicholson as to his *Pleurograpsus*.

5. It is not pleasant to be personal, but it is often necessary—scientific precision and truth require it. Dr. Nicholson has another method. In the first part of his letter in your last number, he says the error (introduced by Mr. Jenkins into the abstract of his paper?) in the generic character of Dichograpsus, "has been reproduced in a recent paper on Graptolites." Would it not have been better to have been personal here, and said, reproduced by Mr. Carruthers? But what is the truth? This *erroneous* character was published by me in June, 1867 (did Mr. Jenkins make by mistake his abstract from my paper?), in a paper which Dr. Nicholson has read, for he has quoted from it. If there is any plagiarism, it is Dr. Nicholson who has stolen from me. But if he prosecutes his enquiries a little further, he will find that this character was not published even then for the first time.

And now, sir, I have done with Dr. Nicholson, and I trust he has for some years done with Graptolites. Let Dr. Nicholson lay aside his honours for a little, and become a *scholar* in natural science, and no one will more heartily welcome him as a worker when he has somewhat mastered his subject, than—Wm. Carruthers.

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[1] Prof. Allman (whose terminology Greene adopts) and Prof. Huxley did me the favour to read and approve my proof.—W.C.

THE

GEOLOGICAL MAGAZINE.

No. XLVII.—MAY, 1868.

ORIGINAL ARTICLES.

I.—On *Saurosternon Bainii*, and *Pristerodon McKayi*, Two New Fossil Lacertilian Reptiles from South Africa.

By Professor T. H. Huxley, LL.D., F.R.S.

President of the Geological Society of London: Hunterian Professor of Comparative Anatomy in the Royal College of Surgeons, etc., etc.

(PLATES XI., XII.)

SOME time since Prof. T. Rupert Jones directed my attention to a curious fossil in the British Museum, obtained by Mr. Bain from Styl Krantz, Sniewe Berg, South Africa. The matrix is of the same nature as that in which the Dicynodonts are so commonly found, and exhibits the greater part of the skeleton, but unfortunately not the skull, of a *Lacertilian* reptile, not more than seven or eight inches in length. It is represented of the natural size in Plate XI., Fig. 1. The trunk is about two and a half inches long, and appears to have attained hardly more than one-third the length of the tail, which is bent round into three-quarters of a circle, and consists of vertebræ, which are very stout near its root, but become attenuated at its termination (*a*). The centra of these vertebræ appear to have been slightly constricted in the middle, and are about one-tenth of an inch in length. The anterior caudal vertebræ present strong and long transverse processes. The dorsal vertebræ can hardly have been fewer than eighteen or twenty, and seem also to have possessed hour-glass shaped centre. They are for the most part provided with long curved ribs, the hindermost four or five pair of which become gradually shorter. One or two vertebræ in front of the sacrum may have been devoid of ribs.

Both the fore and the hind limbs are in place, though but imperfectly preserved The impression of the large semilunar coracoids (Figs. 1 and 2 *b*) which meet, and perhaps overlap in the middle line, is very distinct. But one of the most interesting features of the fossil, and that which best indicates its relation with the typical *Lacertilia*, is the great T-shaped, or rather crossbow shaped, episternum or interclavicle (Figs. 1 and 2, *c*), which in its general form and properties closely resembles that of the existing Monitors. The clavicles themselves are not to be distinctly made out. The humerus is equal to about 7 vertebræ in length, and possesses a cylindrical shaft, which is moderately expanded at each end. The radius and ulna are rather shorter than the humerus. The manus (Fig. 2 *d*) has slender digits, some of which were certainly terminated by claws, and which seem to have been present in the full number of five. The impression of the pelvis is distinctly visible, though its details cannot be clearly made out. The femur is a long and strong bone, not notably dilated at either extremity. The tibia is stouter than the fibula; both bones are considerably shorter than the femur. The total length of the leg without the foot is 1·8 inch; that of the fore-limb without the manus is 1·4 inch. The foot, represented as twice the size of nature, in Fig. 3, seems to have been penta-dactyle, with slender digits, the largest of which could hardly have been shorter than the tibia.

Our knowledge of the characters of the trunk and of the limbs of the Dicynodonts is very defective, but the limb-bones of this skeleton are so unlike any of the corresponding bones which are known among the Dicynodonts, that I think there can be little doubt that the fossil is not the trunk of *Dicynodon*. On the other hand, it is in many respects curiously like *Telerpeton*, and I am disposed to think that the little African reptile, which may be called *Saurosternon Bainii*, was really allied to that famous Lacertian.

At the International Exhibition held at Paris last year, Mr. McKay, of British Kaffraria, exhibited a model of "East London and the Harbour Works at the Mouth of the Buffalo River, British Kaffraria, Cape of Good Hope," with some geological sections. The latter are thus described:—

"EXPLANATION OF GEOLOGICAL SECTIONS. (Figs. 1 & 2.)"

"A.—Is a Permian formation, most probably of the age equivalent to the Magnesian Limestone of England and Zechstein of Germany. Its freshwater origin is inferred from the total absence of Marine remains, particularly shells—and the presence of multitudes of remains of reptiles capable of existing on land or freshwater—together with the remains of land-plants in the erect position in which they grew.

D.—Is a wind-stratified Post-Tertiary formation which fringes the coast for a considerable distance (it has been traced from the Kowie to Natal), but does not extent any distance inland, generally under a mile. It is, in fact, nothing more than consolidated sand hills, which, in some places, attain a height of 200 feet and upwards. The hillocks of loose sand that skirt the coast at the present day are identical in composition, stratification, and organic remains.

E.—Is a stiff, reddish, yellow clay, with a considerable proportion of calcareous matter; pellets and nodular concretions of lime are dispersed throughout it. It occupies all the depressions in the surface of A, and, in consequence, is very irregular in thickness, ranging from 5 to 150 feet. No fossils have yet been found in it.

F.—A thin layer of ironstone gravel, containing rolled fragments of silicified wood, agate, cornelian, chalcedony, etc.

G.—A rich, dark, earthy clay, from 2 to 5 feet thick, with thin layers of existing marine shells sparingly dispersed in it These marine remains have been found at an elevation of 800 feet ("*sic.* in Mr. McKay's MS., at p. 204 he says 200 feet") above the present sea level, so that the land must have been quiescently submerged to that depth within a very recent period.

H.—This deposit owes its origin to an obstruction across the mouth of the river, which has penned back the water and converted the estuary into a temporary lake, about 20 feet above its present level—three distinct occurrences of this obstruction are plainly seen. After carefully observing most of the mouths of the rivers on our coast, I am satisfied that they are all more or less liable to periodical obstructions of this description.

It is only in this deposit (H) that traces of man have been found. They consist of implements, fragments of native pottery and charred wood.[1] It is only when the fossils are close to the underlying hard rock that the process of oöncretion and cementation has made any advance, otherwise they are loose in their bed, or are beached up in heaps of loose shells and rubbish in a direction against the sea, as in H, Fig. 1."

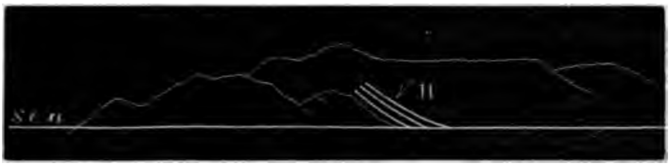

Fig. 1. Hills inside Estuary at the mouth of the Buffalo River, British Kaffraria, Cape of Good Hope. H. Bed of Shells = to H. in Fig. 2.

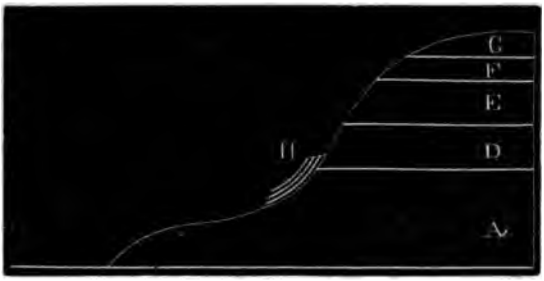

Fig. 2. Order of Super-position of Deposits, Buffalo River.

"LIST OF FOSSILS OBTAINED BY MR. McKAY, OF BRITISH KAFFRARIA."

"Bed A.—All the animal remains of this group are presumed to be Reptilian. No. 1. Section of Vertebræ. No. 2. Vertebræ and ribs. No. 3. Skull of *Dicynodon*, tusks directed forward, inward, and downward; the mouth and temporal fossæ analogous to the existing turtle. No. 4. Bones of the feet, ribs, etc. No. 5. Part of a Skull. No. 6 and 7. Vertebræ and ribs. No. 8. Jaw with teeth placed in a groove. No. 9. Upper and lower jaw with teeth, one of which is serrated. No. 10. Jaw with teeth in distinct sockets, large teeth to the front, and gradually diminishing in size towards the posterior part of the jaw; remarkable for the massiveness of the jaw in proportion to the size of the teeth. No. 11. Small jaw with a row of cylindrical teeth and four supplemental teeth compressed and serrated on the anterior edge only; some elements of the lower jaw. No. 12. Vertebral column of a small reptile; some bones of the legs and sternum. No. 13. Skull with teeth in a groove. No. 14 and 15. Skulls. No. 17. Serrated tooth; two other teeth of this description in my possession are deeply implanted in distinct sockets in a massive jaw; they are serrated on both edges—an attempt was made to clear the serration on the other edge of No. 17, but it was found too brittle, and it shivered with the lightest tap. No. 18. Tooth; the cast of the point of the tooth suggests indentation on the edge of a right angle, rather than projecting serrations; it was associated with No. 17. No. 19. Part of skull and lower jaw teeth, some of which are serrated. Concentric ring-marks are visible in section. No. 20. Rib? No. 21. Tibia? No. 22. Ribs and bones of the feet or paddles? No. 23. Bones of the feet fragments of the jaw and teeth, etc. Lastly. Many plant impressions, ripple marks, and cast of rain drops.

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[1] Since the above was written, Mr. McKay has discovered a fragment of native pottery in a layer of existing shells in the bed G.

Bed D.—Existing land shells, casts of existing marine shells, vertebræ of shark, claw of crustacean, bone of land animal, existing marine shells and fragments.
Beds E, and F, are unfossiliferous.
Bed G, contains existing marine shells 220 feet ("*sic.* in Mr. McKay's MS., at p. 202 he says 800 feet") above the present sea-level.
Bed H, yielded teeth and tusks of *Hippopotamus*; stone ring used by Bushmen. (They are wedged on to the pointed sticks as make-weights to assist in digging up roots.) Lastly. Fragments of native pottery."

The specimen represented of the natural size in Pl. XII. Fig. 1, is from Bed A, and is the fossil marked No. 9 in Mr. McKay's list. It is a shattered lacertilian skull having very much the general shape of that of *Rhynchosaurus*, being very broad posteriorly owing to the large size of the supratemporal fossa (*a*), and tapering anteriorly. The extremity of the snout is broken off. The large orbits (*b*) looking almost directly upwards, lie in the anterior half of the cranium, and are separated by a relatively narrow interorbital space. What appears to be a parietal foramen is situated in the sagittal suture near the truncated occipital margin of the skull. The mandible is very much broken, but what remains of it shows that it was remarkably thick, and that it was provided with teeth, the best preserved of which is represented of twice the natural size in Fig. 1 *a*. Eight or nine such teeth can be counted in relation with the left ramus of the mandible between *d* and *d*. Each of these teeth is straight, flattened from side to side in the crown, but more cylindrical in the fang, and contains a pulp cavity, which extends nearly to its summit, and is wide in the crown of the tooth. The anterior edge of each tooth is like its surface, smooth and rounded, but the posterior is produced into relatively strong and long denticulations.

The ramus of a mandible of the same animal, is represented of twice the size of nature in Plate XII. Fig. 2. From the arrangement of the teeth in this and in the foregoing specimen, it appears that they were not disposed in distinct alveoli, but lay close together in a groove of the bony substance of the jaw. The symphysial end of the ramus (*a*) seems to have been devoid of teeth.

The successional teeth are well seen in various stages of development at the bases of those which are fully formed. Most of the latter have been split, or ground down, so as to show their pulp cavities. I propose to name this new Lacertian *Pristerodon McKayi*.

Fig. 3, Pl. XII. is a figure, of the natural size, of another incomplete mandible, similar in its stoutness, and in the apparent absence of teeth from the symphysial region, to the foregoing. But the transverse sections of the fangs of the teeth, which have been exposed, apparently by taking a slice for microscopic purposes, are oval, and show that the pulp-cavity is almost obliterated. The teeth increase in size from behind forwards, and a thin bony septum between the first and second gives rise to a complete alveolus for the first tooth.

The inner side of the ramus gives off a singular slender bony process, which may correspond with the flat and slender plate of

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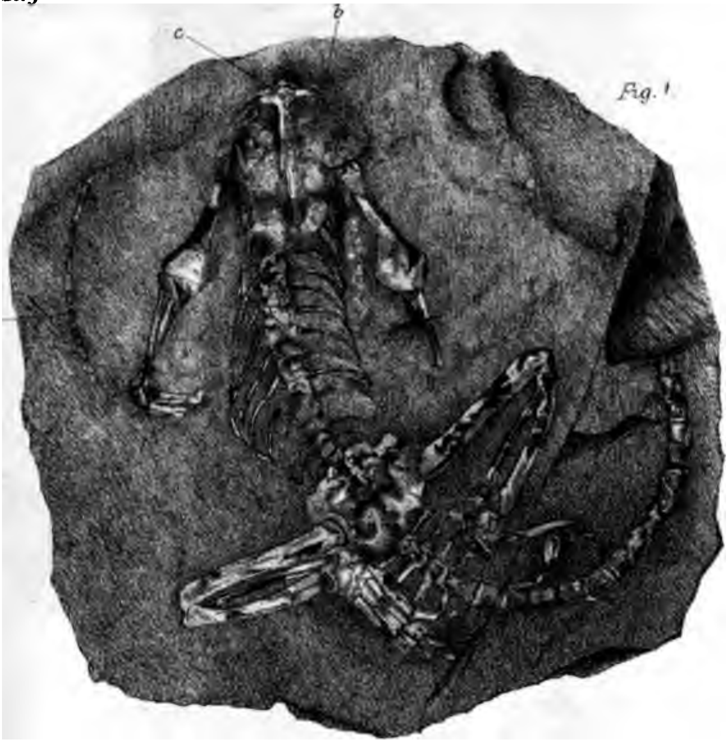


Fig. 1

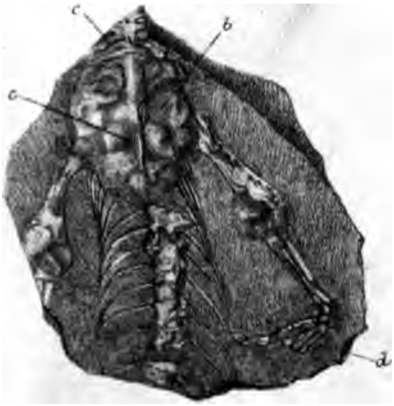


Fig. 2

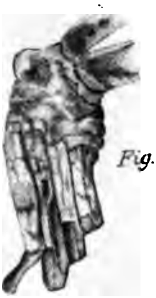


Fig. 3.

W. West

A.T. Hollick del. et lith.

Saurosternon Bainii, Huxley.
ew Fossil Reptile from South Africa.

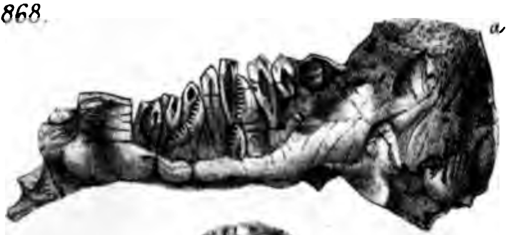


Fig 2.

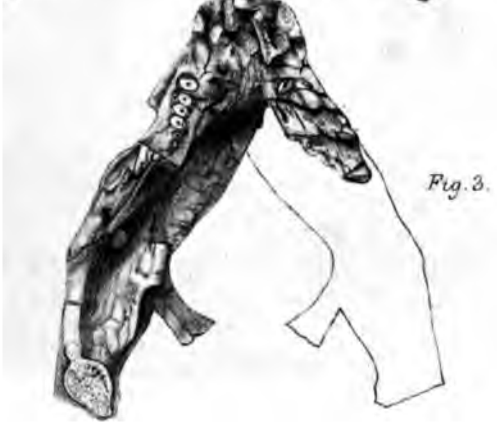


Fig. 3.

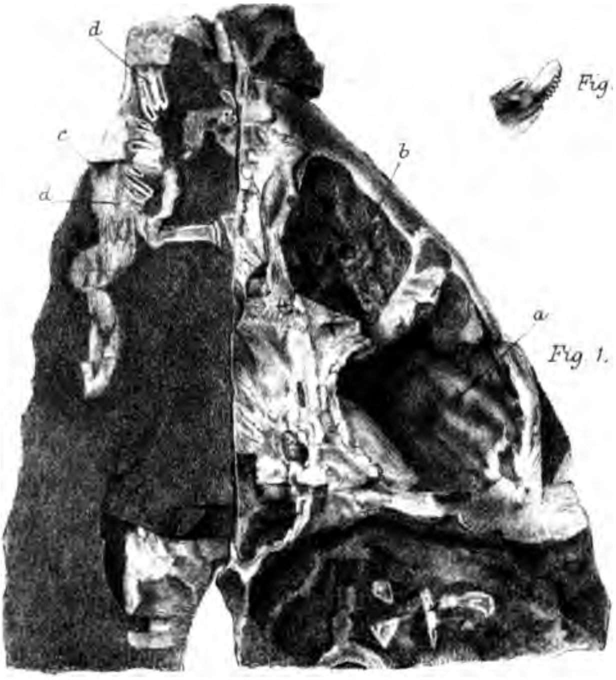


Fig. 1a

Fig. 1.

A. T. Hollick del et lith.

W. West imp.

Pristerodon Mc Kayi, Huxley
A New Fossil Reptile from South Africa.

bone which appears to be given off from the inner side of the mandible of *Pristerodon*, nearly opposite the lower *d* in Fig. 1, Pl. XII.

DESCRIPTION OF PLATES XI. AND XII.

Pl. XI.—Fig. 1. The impression of the ventral face of *Saurosternon Bainii*, of the natural size. *a*, the extremity of the tail; *b*, the coracoid; *c*, the interclavicle or episterna.

2. A portion of the counterpart. *d*, the manus; *b*, *c*, as before.

3. The left foot; from the counterpart twice the natural size.

Pl. XII.—Fig. 1. The skull of *Pristerodon McKayi*, of the natural size. The greater part of the left half of the skull has split off, leaving the left ramus of the mandible (*c*) exposed. *a*, the right temporal fossa; *b*, the orbit; *d d*, the teeth.

1*a*. A tooth, × 2.

2. A detached ramus of a mandible of *Pristerodon*, viewed laterally, and apparently from the inner side.

3. A similar mandible, viewed from above.

II.—ON THE CAUSE OF CONTORTIONS AND FAULTS.

By J. M. Wilson, M.A., F.G.S., etc.; Fellow of St. John's College, Cambridge; Assistant Master at Rugby School.

During the last few years, in lecturing on geology at Rugby School, I have frequently given an explanation of the causes that produce contortions and faults, which I find, to my surprise, is not given in the ordinary text books, and yet seems to me an extremely obvious explanation.

The explanation given by Lyell (Elements, p. 64), is contained virtually in the diagram he gives (Fig. 1). I quote however a few words from his book. "Suppose the mass of rock A, B, C (Fig. 1), to overlie an extensive chasm *d*, *e*, formed at the depth of several miles. Now, if this region be convulsed by earthquakes, the fissures *f*, *g*, and others at right angles to them, may sever the mass B from A and from C, so that it may move freely, and allow it to sink into the chasm."

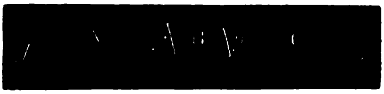


Fig. 1.

It is clear from this that Lyell considers faults as caused by subsidence of detached portions of the crust of the earth; and since a wedge-shaped block could not so subside, the faults must be either vertical or overhanging on one side of the detached portion; that is faults would "hade to the upthrow" as often as to the downthrow, which is not the case.

Phillips, I believe, offers no explanation of faults, but points out the very general law that the plane of separation slopes under the depressed portion of the disrupted strata, expressed above by saying that faults "hade to the downthrow."

Page does not discuss the question.

Jukes discusses it at considerable length, and his explanation, in some respects, is like my own. He explains, however, the general

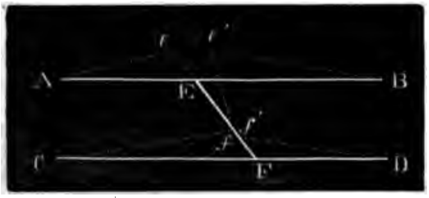


Fig. 2.

law of the inclination of the plane of the fault as follows:—"Suppose that in the diagram (Fig. 2) we have a portion of the earth's crust, of which A B is the surface, and C D a plane acted on by some wide spread force of expansion tending to bulge upwards the part A, B, C, D. If, then, a fracture take place along the line E F, it is obvious that the expanding force will, on the side of A C, have the widest base C F to act upon, while it will have a proportionately less mass to move." Jukes then proceeds to discuss the junction between two opposite faults, which produces what is often called a "trough," of which his explanation only differs in some details from my own; only that my own is applied to all faults, and depends on no hypothetical causes whatever.

Similarly when I read manuals with a view to see what account is given of contortions, I meet with nothing but general allusions to "forces of disturbance," "unequal densities and pressures," and no clear mechanical account of their origin.

Lyell's account is that they may be due to lateral pressure, and two ways of producing lateral pressure are indicated; one by the injection into fissures of molten, or the protrusion of solid rocks, and the other by unequal degrees of subsidence arising from various causes.

Now, contortions and faults are, I think, readily explained when one recollects—

(1) That depressions and elevations take place over large areas.
(2) That the surface of the earth is curved.
(3) That rocks are compressible by foldings.
(4) That rocks are not extensible or elastic.
(5) That at great depths rocks are somewhat plastic through heat.

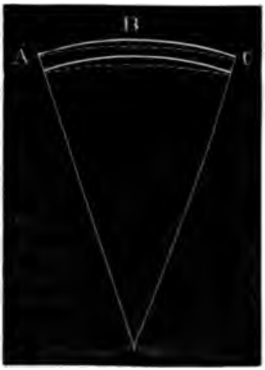


Fig. 3.

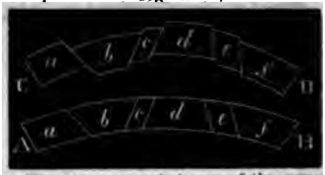
For, consider a portion of the earth's surface A, B, C, (Fig 3) and suppose it to be an area of subsidence, or to sink gradually to the position occupied by the dotted lines. It is clear that to do so it must be laterally compressed. Here is a source of power for producing contortion, viz., the prodigious weight of the mass, slowly sinking, and crumpling up into curves and folds that part of the area A, B, C which yields most to lateral pressure.

Contortions then are the inevitable result of *subsidence* of a *curved* surface.

Now, consider the re-elevation of a district. The rocks have to expand so as to occupy a larger area. How can this be accomplished? Clearly by cracks, passing right through the *solid* crust, taking place in a variety of directions, and all the pieces, which are broader at the surface than lower down, sinking further relatively to the rest.

It will be seen at once by reference to a diagram, which I have made on an exaggerated scale (see Fig 4). If the mass A B is elevated so that it assumes the more curved form C D, A B will crack; (*a*) will rise, and (*d*) will rise, but the increased space between (*a*) and (*d*) will be occupied by the sliding down of the pieces (*b*) and (*c*). Then since these faults always take place when the area is depressed, the rise will take place under the sea, and be extremely slow, and the marine denudation will soon level the surface, and obliterate all trace of faults. It is clear that this explains the general law of faults given above; and puts contortions and faults in connection with one another. *Faults* then are the inevitable result of the *elevation* of a *curved* surface. The only point that needs further examination is this, whether the cause assigned above is *adequate* to produce the observed amount of faults and contortions.

Fig. 4.



The pieces *a*, *a*, *b*, *b*, are of the same size in the two diagrams, and the distance from C to D is equal to that from A to B.

I have examined this question mathematically, and the following are the results I have obtained on the supposition that a circular area of the earth's surface whose diameter subtends an angle of 2 θ at the centre of the earth, is depressed, so as to maintain a spherical form, (of course a portion of a larger sphere) to a depth of (*a*) miles in the centre of the depressed region;—that is on the supposition that the arcs A B and C D, as in the diagram, are both circular. The calculation only requires a little trigonometry, and may be relied on as true within a few yards.

TABLE OF COMPRESSION, IN YARDS.

For an arc of 2 θ, depressed to a depth a; radius = 4,000 miles.

	$\theta=5°$	$\theta=10°$	$\theta=20°$	$\theta=40°$
$a=1$ mile	121	211	354	800
$a=2$ miles	189	408	745	1625
$a=4$ miles	355	788	1584	3214
$a=8$ miles	598	1527	3213	8539
linear distance across depressed area	345 miles	690 miles	1380 miles	2760 miles

The inspection of this table will shew that the known rising and sinking of large areas of the earth's surface *is adequate* to produce much compression and extensive faults. But this table can be made to yield some other important results.

When the geological structure of a country is pretty well known, the *amount* of contortion,—*i.e.* the difference between the direct distances of two distant points, (1) measured along a circular arc, (2) measured along strata,—may become approximately known. And if this contortion appears not to be due to the intrusion of local igneous rocks, and does appear to be due to depression, we get a means of calculating to what depth the strata sank when those contortions were being produced.

And, again, it appears that the horizontal projection of the fault, or, in other words, the "barren ground," is the measure of the *power* of a fault. Hence, if the vertical throw of a fault be f, and the inclination of its plane to the vertical be θ, and the barren ground be therefore $f \tan\theta$, it appears that $\Sigma\ (f \tan\theta)$, taken along any section, is a measure of the subsequent elevation. But $\Sigma\ (f \tan\theta)$ is an observable quantity, independent of hypotheses: hence we may be able to infer the amount of re-elevation, which ought to correspond approximately with the amount of depression obtained for the same section from the contortions.

But apart from this application of my explanation of the origin of contortions and faults, which is not yet, I imagine, practicable, I should be glad to know the opinion of geologists about the explanation itself.

III.—ON BANDED AND BRECCIATED CONCRETIONS.

BY JOHN RUSKIN, ESQ., F.G.S.

(PLATE XIII.)

(CONTINUED FROM THE APRIL NUMBER, P. 161.)

THE next group of agates which I have to describe belongs to the nested series; but is distinguished from all other varieties of that series by having a pure chalcedonic surface (unaffected, except in the form of it, by the material of its gangue); and by uniformity of colour; consisting only of white and transparent grey bands, wholly untinged by more splendid colours. But nearly all the agates of this group which now occur in the market have been dyed brown or black at Oberstein, to the complete destruction of their loveliest phenomena.

With the true agates of this group must be associated some transitional examples, in which the surface is more or less entangled with, and degraded by, the material of the gangue, (the body of the stone then becoming susceptible of colouring by iron, or of chloritic arborescence from the exterior); and others, in which the mass is rudely egg-shaped, like a rolled pebble, and the crust is of a fine

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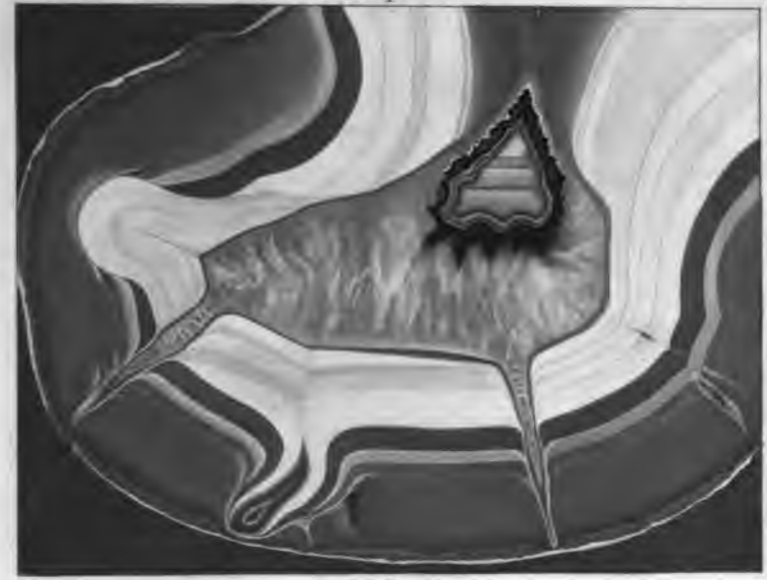

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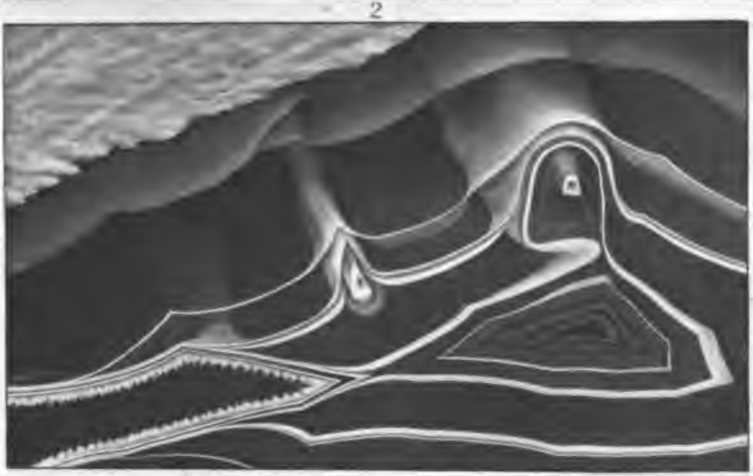

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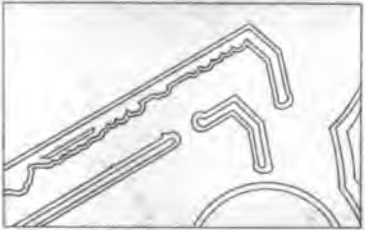

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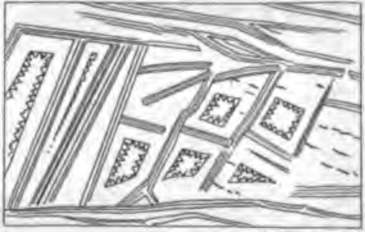

J. Ruskin, delt
G. Allen, inc.

FOLDED AGATES AND MURAL AGATES.

pale brown agatescent jasper in multitudinous concretions, plainly visible on the surface, like the convolutions of the brain of an animal. But in the typical examples of the whole series, no lines of concretion are visible on the surface; it is knotted and pitted; but not banded—it is of grey clear chalcedony, and the entire mass of the stone is often thrown into irregularly contorted folds, which are sometimes parallel to the interior bands, and from which I shall, for convenience sake, give the name to the whole group of "Folded Agates."

I say "sometimes parallel," because the folds of the interior beds are much more complex than those of the surface, and often are most notable when the exterior is undisturbed; and they are specifically peculiar in two respects. First, they are formed out of beds which are in the greater part of their course accurately parallel, and arranged in gracefully sweeping continuous curves, while the bands of ordinary agates are broken into minor undulation, and run into irregular curves. Fig. 1 is the typical structure of common, and Fig. 2 of folded agate; the line *a b*, in each figure, representing the surface of the stone.

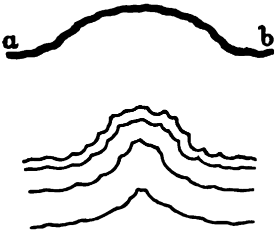

Fig. 1.

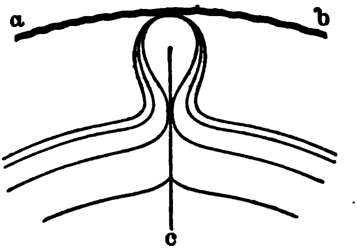

Fig. 2.

Secondly, These sweeping and beautifully parallel beds are at particular points of their course suddenly and systematically contracted, and bent outwards, (outwards, that is to say, in nested agates—inwards in stellar agates, but the stellar formation is very rare in this group) like flowing drapery raised by a rod beneath it; and this ideal rod may either raise these sheets of drapery hanging over it, as clothes hang over a line; or on the end of it, as the sides of a tent hang from its pole;[1] with every variety of beautiful curvature, intermediate between these two arrangements. The ideal rod is of course composed of the interior chalcedony or quartz; and I once supposed the entire range of these phenomena to be dependent on the former subtle influx of the dissolved silica at the points where the apparent rods or tubes reached the exterior of the stone; but I now believe rather that, taking Fig. 3 as a formal type of a perfect folded agate, the points *a, b, c*, etc., at the sides of the nest have been those of *impeded* secretion or deposit (if, which is not by any means clear to me, there has been successive deposit at all), and that the intermediate curved beds are the increasing stalactitic masses. The right lines indicating flaws at the intersection of these masses, are essential in the typical structure. The two upper figures in Plate XIII. will characteristically represent the phenomena principally resultant, though the complexity of these phenomena is so great that in detail they can only be followed out by the reader with good specimens of the stones in his hand.

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[1] In Plate XIII. Fig. 1 shows the clothes-line arrangement in pure surface-section, and Fig. 2 in perspective, seen through the transparent stone, the edges only of the pendant veils being at the surface. Of the tented arrangement I will give examples in succeeding plates, but they are not specifically different arrangements; they are only accidental variations in the direction of the interrupting masses.

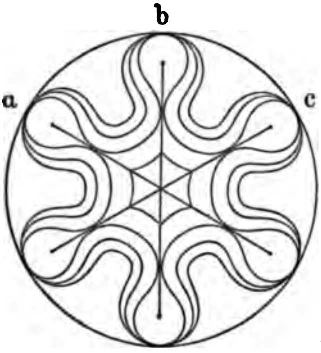

Fig. 3.

Fig. 1 is from a very rare agate in my own collection, which unites the characters of the folded group with that of the nested agates which have level beds (the pure folded agates never, as far as I have seen, contain rectilinear tracts), and the folds, or tubes of arrest, in this stone are less regular in structure than in typical examples, and present somewhat the appearance of having been caused by contraction, the rent spaces being afterwards filled by the inner quartz. But I believe this appearance to be wholly deceptive. Whatever the cause of the interruptions may be, they are certainly not mere rents like those of septaria. The greater width of the white band at the top, which suggests the idea of large influx there, is a sectional deception; this white band is of equal thickness everywhere; and, with all the others, seems entirely concentric, except when interrupted by the tubes, and by the changes in the direction of the films in its own substance which are connected with them. Fig. 2 is from a piece of perfect folded agate, showing the symmetrical arrangement of its successive beds round the tubes, and their lovely dependent curves as they detach themselves. In some cases, however, the tubes appear isolated in the mass of the stone, or interrupt the beds in their own thickness; but in whatever accidental relation to the secreted chalcedony, they assuredly indicate a peculiar state of its substance at the time of secretion; and their nature, and the conditions under which they develope themselves, must be understood before we can hope to explain the more complex tubular formation of dendritic chalcedonies.

And this investigation is rendered doubly difficult by the perpetual confusion in all agatescent bodies between the concretionary separation, and successive deposit of their beds. If these folded agates were, indeed, formed in successive beds, from without inwards, as it has been supposed, it should be possible sometimes to trace the point of influx of material, and the sequence of the added bands from it, which I never yet have been able to do satisfactorily in a single instance in folded agates (and only with suspicion of the appearance of it, even in the brown coated and level bedded stones in which it seems to be of ordinary occurrence): and also, the beds ought to present some of the irregularly accumulate aspect of common calcareous stalactite; and in the interior we ought to find sometimes vacancies left by the failure of supply. But on the contrary, folded agates are always *full*, so far as I have seen, except occasionally in the centres of their tubes, or in hollows of outer folds, but they are always closed in their centres (differing, observe, again *essentially* from common agate in this circumstance), and their beds are not only parallel, instead of irregularly heaped, but involved in the strangest way in reduplicate crystalline series. See the interior of the stone, Fig. 2, in Plate XIII.

On the other hand, were they truly concrete, these beds ought to exhibit occasionally clear evidence of subordinate concretion in their mass. Thus in the true concrete jasperine agate, Fig. 4,[1] the beds which are simply concurrent on the right hand break up presently, and separate into flamy and shell-like groups, transverse to the general bedding, and at last bend round a knotted nucleus; but nothing of this kind ever occurs in folded agates, though their veils of dependent film are sometimes covered with an exquisite dew of minute pisolitic concretions, making them look (under the lens) like a beautiful tissue of gossamer laden with dew, and connected with a peculiar complex basalt-like fracture: then finally, to finish the difficulty, these folded agates are connected by a series of scarcely distinguishable transitions with the group which we shall have next to examine, which seems to be in great part concretionary, but concretionary in right lines. The two lowest figures in Plate XIII. are outlines of two of the most singular conditions of it. Fig. 3, Plate XIII. is reduced in scale from a stone which I shall hereafter engrave of its real size, as its mode of association of agatescent with crystalline structure is, as far as I know, unique—and its proper discussion is connected with that of the modes of increase of crystals. Fig. 4, Plate XIII. is from an agate of almost equal rarity, though I have seen other examples of its structure, but never so decisive in character. This figure is slightly enlarged, being of a portion of a mass which has crystallized out of a breccia, in thin walls of linear brown agate enclosing opaque white agate, leaving internal spaces filled with quartz.

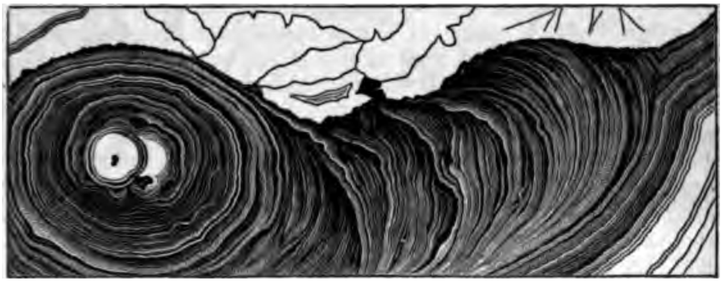
Fig. 4.

The entire group to which these examples belong, consisting of walls, or tabular crystallizations, of agate, I shall name Mural agates; and they are connected, on the one hand, with Folded agates, by a series in which tabular portions of the external matrix are torn off like pieces of broken slate, lifted up into the agatescent mass, and then encrusted with folds of chalcedony; on the other hand, when the Mural fragments become curved, they are connected with a great jasperine group of the most curious interest, which I shall examine under the general term of Involute Agates, consisting of bands of a consistent structure, broken up (or fragmentarily secreted), Fig. 5, A, in fine specimens disposed in curves resembling the contour of a haliotis shell, Fig. 5, B, but in less developed examples forming broken vermicular concretions in a jasperine paste, Fig. 5, C. It is almost impossible without microscopic examination to distinguish some of these shell-like concretions (of which the most delicate are white, closely crowded, and surrounded by milky chalcedony), from true organic remains; and to my mind perhaps the most singular fact, of all that are connected with minor physical phenomena, is this apparent effort of the occult natural powers to deceive their investigator, by making one thing resemble another. There seems to be a mocking spirit in Nature which sometimes plays with its creatures, as in the orchis tribe of plants, or the mantis group of insects; and sometimes deliberately connects two totally different systems of its work by deceptive resemblances, causing prolonged difficulty or error in the attempt to discriminate them. In this subject before us, for instance, the inorganic secretions of chert and flint are connected, by the most subtle resemblances, with those which have organic nuclei; the filiform and foliated secretions of chlorite, and the flamelike and infinitely delicate mossy traceries of jasper, pass with the cunningest treason into the organisms of altered sponge and wood; the pisolitic and radiated-crystalline agates confuse themselves with true corals; the involute agates with shells; the rolled breccias with slowly knotted secretions; and all the phenomena of successive deposits, quite inextricably with those of segregation! I imagine, however, that the reader must have had enough, for the present, of these mere statements of doubt, and as my next subject, mural agate, is a very difficult one, I shall delay the paper for some time; but meanwhile, if any good chemist would set briefly down for me what is now positively known of the fluent and gelatinous states of silica, and silicate of iron, with respect to their modes of separation, when undisturbed, from other substances, it would be of the greatest service to me (and not, I should imagine,) irrelevant to the general

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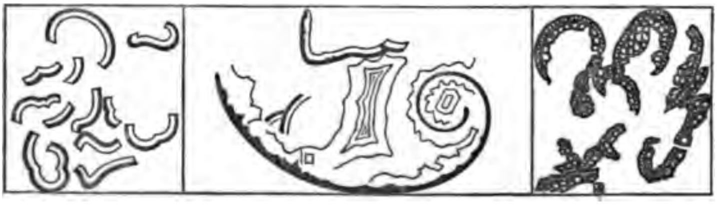
[1] Magnified about three times.

Fig. 5.


A. B. C.

purpose of this Magazine; for all inquiries respecting metamorphic rocks must rest on such chemical data primarily); and, also, I should be grateful to any mineralogist who would give me some tenable clue, or beginning of clue, to the laws which affect the modes of crystalline increase; that is to say, which determine whether a prism of quartz or calcite shall increase at the extremities or at the flanks, or consistently on both, or inconsistently at different parts of the prism; and, especially, by what law stellar or or roseate aggregations take place, instead of confused ones, in groups of crystals; and by what tendencies some minerals, fluor for instance, are limited in their expansions of the cubic or other common form, while others, such as salt and the oxide of copper, are enabled to shoot unlimitedly into prismatic needles; and others, like sulphide of iron, will form in solid crystals on the outside of calcite and in stellar acicular groups within it. If I can get some help in this chemical and microscopic part of the work, which I cannot do myself, I have hope of being able to give something like a serviceable basis for future description of the two great groups of calcite and silica, and the modifications of iron which colour the concretions of marble in the one case, and of agate in the other; and I should do this piece of work with, perhaps, more zeal and care than another person, owing to its connection with my own speciality of subject, by the use of these two earth-products in the arts, and the foundation of much of what is most beautiful in architecture, and perfect in gem-engraving, on the accidents of congelation which have veined the marble and the onyx. J. RUSKIN.

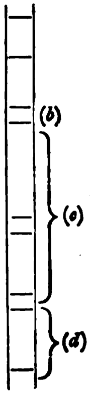
DENMARK HILL, 22nd April, 1868.

IV.—A FEW NOTES ON CLACTON, ESSEX.

By the Rev. O. FISHER, MA., F.G.S.

THE following is taken from a MS. by the late Mr. John Brown, F.G.S., of Stanway, Essex, and given by him to Professor Henslow, who gave it to me. The actual measurements are not mentioned, but I believe the scale to be about an eighth of an inch to a foot. It is valuable as having evidently been made when the beds were better seen than usual. Moreover, the constant waste of the cliff alters the section continually.

"1. Vegetable Soil..
2. Loam with interspersed flints, both rounded and angular, white quartz pebbles, and Quartz Sandstone in boulders......................
3. Freshwater shells in red sand..
4. Peat...
5. Marine and freshwater shells...
6. Peat, with subordinate and interrupted beds of marine and freshwater shells (tooth of water rat)......................................
7. Marine and freshwater shells...
8. Bones of the larger mammalia, generally found between the cliff and low-water-mark, freshwater shells, trunks of trees, nuts, and seeds, as we find in the upper beds: no marine fossil shells.........
9. London clay at the junction of low-water-mark" ....



To this I append a quotation from a paper by the same geologist in the Mag. Nat. Hist., vol. iv., p. 197, 1860:—

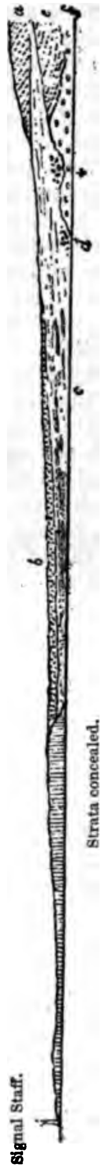
"The hollow or basin occupied by this deposit" (I conclude he means the exposed section of it) "measures about 600 yards in a north and south direction, and at low water it can be traced for about 80 yards eastward from the face of the cliff, and it doubtless extends much further under the sea, as the freshwater shells and bones of the fossil mammalia are seen lying in their lacustrine beds close up to low-water-mark."

I never could find the bed (*d*) exposed on the shore as Mr. Brown did. But specimens of the *Unio litoralis*, and of the black and white pebbles from the top of it, are by no means uncommon at low water exactly opposite (*d*) in the cliff. Even in the cliff the bed (*d*) is seldom now to be seen without digging for it, and then it can only be found extending a very few feet.

In Mr. Brown's section No. 2 is what I call "trail."

The woodcut (Fig. 2) is copied from a sketch, made on the spot, of the manner in which the "trail" (*a*) cuts into (*b*), where it is five feet thick, above the peat (*c*) at a spot about 160 yards west of (*d*), in the diagram. For about 600 yards to the west beyond the end of the low cliff the shore at low water is occupied by London clay; and then commences a submarine forest with the stools of trees rooted in the London clay. It is covered with the usual *Scrobicularia* clay, the *Scrobicularia* and other shells being of large size, and in that respect very unlike those in the older peaty deposit, which covers the Lower freshwater bed. I saw some small lagoons behind the present beach, where a deposit exceedingly like the old peat is now in course of formation. It seemed to show that the sandy layers in the old peat were caused by sand being blown into pools of brackish water.

Fig. 1.—Diagram of the Post Glacial Cliff at Clacton, Essex. Horizontal Scale 1 inch = 80 yards.



(*a*) Obliquely bedded gravel of unascertained relation, newer than (*b*), but older than "trail."
(*b*) Sandy clay with *Corbicula* (*Cyrena*) *fluminalis*, small *Cardium edule*, *Paludina lenta*, *Rissoa thermalis* (Wood's Crag Mollusca, Vol. ii., p. 39). This part of the cliff is about 20 feet high.
(*c*) Peaty shale with small *Scrobicularia*, Portions of *Balani*, and brackish water shells.
(*d*) Freshwater deposit containing oak wood, hazel nuts, sticks, *Helix*, *Bithynia*, *Unio litoralis* and mammalian bones (J. Brown); A layer of black tints and white quartz pebbles, with shells of *Unio*, separates this from the peaty shale above.
(*e*) Glacial gravel horizontally stratified.
(*f*) London clay with septaria.
At • the peaty shale was broken up and lying at all angles on the London clay.

Just beyond the second groin going from East to West, a layer of muddy clay containing roots of herbaceous plants, immediately beneath the shingle's foot, is overlaid by a laminated clay with indurated nodules in the laminations, which appears to me to offer a curious instance of *quasi* cleavage. This laminated clay is full of "slikenslide," and its peculiar condition seems to be due to some heavy weight, perhaps of a shingle beach, pressing it towards the sea, and by the pressure causing layers of it to become indurated (see Fig. 3).

FIG. 2.

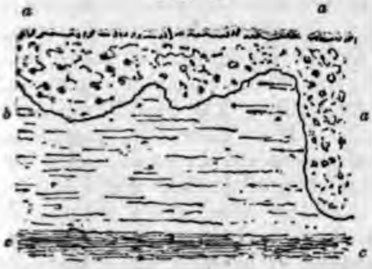
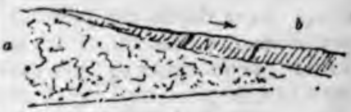


FIG. 3.



(*a*) Clay with rootlets.
(*b*) Laminated clay with indurated nodules parallel to the laminations.
The arrow shows the probable direction of the efficient part of the pressure.

Some caution is necessary in accepting fossil bones as the produce of the Clacton deposit. Fossil bones are frequently procured off the Essex coast in the process of dredging, and, being sold by the Clacton fishermen, are said to come from Clacton. There is no reason to suppose that some of them may not come from an extension of the deposit (*d*), and others probably from beds of the same age; but their different mineral condition will at once show that they have not been obtained immediately from the bed beneath the cliff. The bones from thence, which Mr. Brown deposited in the British Museum, are black and fragile. Those which are dredged are reddish brown, ponderous and strong. This is the condition of most of the dredged bones which I have seen, whether from the Essex, Suffolk, or Norfolk coast. It would be worth while to enquire how their condition of mineralization becomes thus altered, as it appears to be, by the action of sea water. It seems to me probable that the peculiar condition of the rolled bones of the Crag-deposits, which have been derived from older beds, may be accounted for in the same manner. Bones are also obtained from the submarine forest at Clacton, which, unless I am very much mistaken, is of an age long posterior to the deposit (*d*). This case of the juxtaposition of mammaliferous beds of very different ages is similar to that described by Mr. Dawkins as occurring at Pagham, on the coast of Sussex.[1]

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[1] Pleistocene Mammalia Palæont. Vol. xviii., p. 25.

V.—THE FOSSIL INSECTS OF NORTH AMERICA.

By SAMUEL H. SCUDDER, Curator of the Museum of the Boston Society of Natural History, U.S.

(CONCLUDED FROM THE APRIL NUMBER, P. 177.)

Some years ago, Dr. Dawson, who has himself been very successful in the discovery of insect-remains, described and figured[1] fragments of a species of myriapod under the name of *Xylobius sigillariæ*. The remains, many of which occurred in coprolites of reptiles, were obtained at the Joggins, in upright Sigillaria trees, between coal-groups fourteen and fifteen of division four in Dr. Dawson's detailed section of the Nova Scotia formations.[2] As his descriptions of the animal and its mode of occurrence[3] are easily accessible to English geologists, it is needless to refer to them more explicitly. The coprolites, however, yielded some true insect remains;[4] these, as well as fragments of insects, not coprolitic,[5] were kindly sent me for examination by Dr. Dawson. They consist almost entirely of crushed and indeterminate masses of chitinous matter; the few detached and connected abdominal segments which can be distinguished invariably show that the abdomen was slender and the insect of medium size. Beyond this, little can be said of them. I noticed, however, two remains of eyes; one crushed, distorted, and ill-defined, the other, the beautiful fragment mentioned by Dr. Dawson,[6] whose original size it is difficult to determine. The facets are large and regularly disposed, somewhat resembling the *Perlidæ*; but the proportion of the eye to the body varies so much in insects that it is impossible to judge of the size of the animal to which this fragment belonged. A few articulations of an antenna are seen on one of the stones; they probably belonged to a very small or very young cockroach. All the remains of insects appear to be neuropterous or orthopterous. I believe I have distinguished five different kinds. There were also two leeches belonging to distinct genera.

Dr. Dawson states that he has seen a fossil fern (*Cyclopteris* [*Aneimites*] *acadica*) from the Coal measures of Nova Scotia which bore tracks like those made by mining insects.[7]

Remains of insects, much more completely preserved than those which I have mentioned, have been found in the Carboniferous rocks of Morris, Illinos. The beds from which the fossils are derived lie near the base of the Illinois Coal-measures. In the locality at

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[1] Quart. Journ. Geol. Soc. Lond., vol. xvi. pp. 271–3; vol. xviii. p. 6; Can. Nat. vol. viii. pp. 280, 283, pl. vi. figs. 57–61; Air-breathers of the Coal Period, pp. 63, 64, 67, pl. vi., figs. 57–61, 8vo., Montreal, 1863; Acadian Geology, Suppl., p. 36, fig. 45, 18mo., Edinburgh, 1855–60.

[2] Quart. Journ. Geol. Soc. Lond., vol. xxii. p. 116.

[3] Quart. Journ. Geol Soc. Lond., vol. ix. pp. 58–63; vol. xvi. pp. 269–70; Acadian Geology, p. 161; Suppl. p. 33.

[4] See also Quart. Journ. Geol. Soc. Lond., vol. xviii. p, 6.

[5] From Coal Groups 7 and 9 of div. 4; Quart. Journ. Geol. Soc. Lond. vol. xxii. pp. 113, 114.

[6] Quart. Journ. Geol. Soc. Lond., vol. xviii. p. 6; Can. Nat. vol. viii. p. 276, pl. vi. fig. 56; Air-breathers of the Coal Period, p. 59, pl. vi. fig. 56.

[7] Quart. Journ. Geol. Soc. Lond., vol. xviii. p. 5.

Morris they form the overlying deposit, but a short distance beyond, at Murphysboro, the beds are capped by others and their stratigraphical position made clear. The following section given me by Mr. Lesquereux will afford an idea of their relation to the surrounding strata:—

Murphysboro	The true coal as it occurs in Illinois	
	Sandstone	200 ft.
	Coal	5 ft.
	Soft blue Shales with pebbles containing Insects, etc.	40 ft.
Morris	Coal (Morris coal)	3–4 ft. at Morris 5 ft. at Murphysboro
	Shales	40 ft.
	Millstone Grit-conglomerate	6 ft.

At Frog Bayou, in Arkansas, the millstone grit is much more extensively developed, and the insect shales lie directly beneath it.

The fossils at Morris are enclosed in biscuit-shaped ironstone nodules. On weathered surfaces, these nodules show a tendency to lamination, but the interior has a homogeneous, compact structure of a greyish colour; the enclosed fossil seems to have been the nucleus around which the concretionary action took place.[1] The remains consist of reptiles, insects, amphipod crustaceans, worms, and plants. Several insects were found, two of which have been described by Professor Dana[2] under the names of *Miamia Bronsoni* and *Hemeristia occidentalis.* In a letter written to Professor Dana,[3] I gave my views of the zoological relations of these animals, and subsequently published an extensive memoir,[4] discussing some questions which arose from their study. In both of these insects, the wings were all preserved, and, in one case, the greater portion of the body also; but as the wings were embedded in the concretions in their natural position in repose, overlapping one another, new difficulties were added to the determination of their affinities. A close examination of this intricate network of crossed veins enabled me to assign to each wing its respective veins; the body, also, of *Miamia* permitted restoration. Heretofore no naturalist had made use of the structure of the wings in distinguishing the families of *Neuroptera* from each other; but, confident of success, I made careful comparisons among the living types, and found that characters drawn from these parts were both important and reliable. I showed how a formula of the structure of the wing could be laid down for every family, and thus came to the conclusion that *Miamia* and *Hemeristia* were types each of a new family of *Neuroptera,* synthetic in character, combining peculiarities both of *Neuroptera* proper and of *Pseudoneuroptera.* I subsequently came to similar conclusions concerning some of the Devonian insects and the *Haplophlebium* from the Carboniferous rocks of Cape Breton. In the case of *Miamia* and *Hemeristia,* I have ventured to define and name the families to which they belong, calling them respectively *Palæopterina* and *Hemeristina.* From the remains of the body we may judge that the habits of *Palæopterina* were similar to those of *Sialina.*

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[1] Meek and Worthen. Proc. Acad. Natural. Sc. Philad. 1865, pp. 41–2.

[2] Sill. Amer. Journ. Sc. and Arts [2] xxxvii. p. 34.

[3] Sill. Amer. Journ. Sc. and Arts [2] xl. p. 268.

[4] Memoirs Bost. Soc. Nat. Hist. vol. i. pp. 173–92, pl. vi.

Remains of two other animals, found in the ironstone concretions at Morris, have been described by Messrs. Meek and Worthen.[1] One form was considered a Myriapod; the other, the woolly caterpillar of a moth. If the latter were truly a caterpillar, it must have belonged to one of the higher families (*Arctiadæ*), and the discovery would be one of the most interesting facts in the recent history of fossil embryology. It must be confessed that the resemblance of *Palæocampa anthrax* to a caterpillar is very striking, but, judging from the descriptions and figures, I am inclined to refer both of these imperfectly preserved remains to the class of worms.. The hinder half of the body of the so-called myriapod (*Anthracerpes typus*) tapers to a point, and the extremity, which is furnished with a few setæ, bears little resemblance to the form of myriapod. Neither head nor legs are represented on the plate.

Passing upwards, we have next, in the Triassic rocks of the Connecticut River, some questionable tracks, referred by Hitchcock to insects and myriapods: little attention has yet been paid to them.

Remains of insects, which I believe to be larvæ of *Coleoptera,* have been found in slates similar to those in which the fossil fish of the Connecticut River occur; but Professor Marsh informs me that the two remains have never been found directly associated with each other. Professor Hitchcock has described and figured these larvæ under the name of *Mormolucoides articulatus,*[2] stating that Professor Dana considered them neuropterous. Dr. Le Conte, having examined the figures alone, expressed an opinion that the animal was the larva of a neuropterous insect, belonging to the family of *Ephemeridæ.* Dr. Hitchcock then desired the name to be changed to *Palephemera mædieva,* by what just law of zoological nomenclature I do not know. I shall, therefore, in writing, retain the original name of *Mormolucoides articulatus.*

Professor O. C. Marsh has kindly lent me a slab containing from twenty to thirty specimens of this insect, and I have examined individuals in the Museum of the Boston Society of Natural History. So few of the insects have a single segment of the body perfectly preserved, that it is difficult to make out their real form; enough can be seen, however, to warrant the following statements and descriptions:—

The body is formed of fourteen segments; the first two are rather smaller than the others. The first segment is quadrangular, and

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[1] Geological Survey of Illinois, vol. ii. p. 409–10, pl. 32, figs. 1, 1*a*, 3. Proc. Acad. Nat. Sc. Philad., 1865, p. 51–3.

[2] Ichnology of Massachusetts, pp. 7, 8, pl. vii., figs. 3 and 4.

twice as broad as long; the angles are well rounded; the front is deeply excavated, and the two lobes thus formed have elevated bosses. The second segment is a little larger than the first, and is regular in form, twice as broad as long, and has rounded sides. The third and largest segment of the body is twice as broad as the second, but of the same form and proportions; the rest are of a similar form, but grow very gradually smaller, and, toward the extremity of the abdomen, proportionally longer. The last segment is no broader than the second, and nearly square, with rounded angles: a dorsal mark, consisting of two impressed lines, lying parallel and close together, extends the whole length of the body.

Where the dorsal surfaces are exposed, there are no signs of appendages, but, in a single case, the upper surface seems to be presented to view. Here, the anterior extremity is imperfect, but on either side of the first three segments which are preserved, slight elevations appear to be indications of legs. The inner edges of these elevations are bent at right angles, the angle being directed inward and rounded off, so as to make the elevations appear almost crescent-shaped; on the outer side, the elevated portion slopes gradually away. The segments composing the body are widely separated from each other, and, in many cases, actually parted; they must have been of a horny, or, at least, a coriaceous texture, with a slighter connecting membrane. Fragments, consisting of one or two segments, are scattered about on the stones.

The drawings given by Dr. Hitchcock are inaccurate, if the specimens before me belong, as I suppose, to his species. He has figured them with lateral appendages of a peculiar character. I believe these do not exist—but, that, in all cases, the sides of the segments are regularly and symmetrically curved. Unless they are examined with great care, one might easily believe in such a lateral prolongation of the segments, but this appearance is always owing either to the imperfect state of the specimens or to their incomplete exhibition upon the stone. It was chiefly on account of these appendages that Dr. Le Conte referred the insect to the *Ephemerina*.

There is but one specimen on Professor Marsh's slab where the anterior segments are well defined; even here, they have a deceptive anomalous appearance, similar to the large drawing in Dr. Hitchcock's last work.

Judging from the form of the *Mormolucoides*, from its being provided with feet on the thoracic segments alone; and, from the fact, that all the segments were evidently formed of hard shells—I am convinced that the remains must be larvæ of coleopterous or neuropterous insects. The nature of the segments, indeed, would be in exact keeping with a myriopodal character, but the absence of any indication of legs upon the posterior segments, and the small and fixed number of the segments themselves, prevent our referring them to that group. The slight development of legs seems to preclude the possibility of their belonging to *Neuroptera*, and we are thus inclined to consider them coleopterous larvæ. They certainly remind one of some *Cebrionidæ*, but the only known larva of that group lives on the roots of plants, and would not be likely to occur in such a deposit as that in which these remains were found.

The only specimens of insects from the Tertiaries of North America were discovered, in 1865, by Professor William Denton, in the valley of the White River, Colorado, near the confines of Utah.[1] This valley lies just west of the main chain of the Rocky Mountains, and, according to Professor Denton, the rocks all belong to the Tertiary age. The country in which they occur is a most remarkable one; the whole surface is bare rock, eroded by water into ravines and cañons, gorges and valleys, a thousand feet in depth.[2]

The following table gives Professor Denton's view of the superposition of the rocks; the thickness of the several deposits is only estimated. The upper beds are found near the junction of the White and Green Rivers in Utah; the lower ones, near the Parahlamoosh Range, where they are covered by immense beds of lava.

1	Red and white sandstones	Seen, but not examined	2000 ft.
2	Brown sandstones, passing occasionally into conglomerate and alternating with thin beds of blueish and cream-coloured shales, all dipping to the west at an angle of about 20°. Probably of Miocene age.	Turtles; fragments of large bones and teeth of mammals; fossil wood of deciduous trees. Perpendicular veins of petroleum coal. In the lower shales *Insects* and leaves of deciduous trees.	1200 ft.
3	Petroleum shales, varying in tint from a light-cream to inky blackness. One bed, 20 feet thick, resembles cannel coal.	Innumerable remains of *Insects* and leaves of deciduous trees.	1000 ft.
4	White or light-brown sandstones. White shales, on which are ripple marks. Brown shales and shaly sandstones.		800 ft.
5	Thick white sandstones and brown shales. Thick brown sandstones.	Brown sandstones, weathered into cavities.	1000 ft.
6	Sandstone, limestone, shales, blue, brown, and black underclays. Beds of coal or lignite. Brown sandstones and shales, very soft. Coal in several beds, with underclays. White sandstones, with alternating blue shales.	Limestone contains conchs and small gasteropods. Two wide expansions of White River Valley have been made where the soft shales occur.	2700 ft.
7	Compact red sandstones. White sandstones. Red sandstones, shaly and micaceous. Thin fetid limestones.	Fragments of shell in the limestone.	1400 ft.
8	Yellow soft sandstone		300 ft.
9	Gypsum		200 ft.

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[1] Proc. Bost. Soc. Nat. History, vol. x., pp. 305–6, vol. xi., pp. 117–8; American Naturalist, vol. i., p. 56; Hollister; The Mines of Colorado, pp. 378–87, 12mo. Springfield, 1867.

[2] Hollister, Mines of Colorado, p. 383.

I have examined specimens from Bed No. 3, above; perhaps, the lower shales of No. 2, in which insect remains occur, belong properly to No. 3. The fossils were brought from two localities, called, by Professor Denton, Fossil Cañon and Chagrin Valley; they were about sixty miles apart, but the rocks in both cases were the same. From the specimens I have seen, I should judge that the shales were deposited at the edge of a fresh-water lake.

Ninety specimens, embracing about sixty-five species, were brought home; many of the little slabs contain several species of insects, but the remains are often too fragmentary and imperfectly preserved for identification. Two-thirds of the species, and, at least, three-fourths of the specimens, are dipterous; some of these are stout, aquatic larvæ, whose more advanced stages are not represented on the stones. The perfect *Diptera* are mostly *Mycetophilidæ* and *Tipulidæ;* there are also some small *Coleoptera* and a few *Homoptera, Hymenoptera, Lepidoptera,* and *Physopoda.* The *Homoptera* are represented by species allied to *Issus, Gypona,* and *Delphax;* well preserved specimens of *Myrmica* and *Formica* represent the *Hymenoptera.* A poorly-preserved Moth, apparently a Noctuid, is the only member of the *Lepidoptera,* unless one of the larvæ prove to belong to some genus resembling *Limacodes.* Perhaps the Physopod, belonging to a group which has never been found fossil, is of the greatest interest: it differs essentially from all of Heeger's illustrations of this group. The abdomen is scarcely larger than the thorax; the veinless under wings are almost as long and—near the tip—quite as broad as the upper wings. Both the upper and lower veins of the upper wings are connected with the margin by cross-veins, which occur, at about one-third and two-thirds of the distance, from the base to the tip of the wing. The principal veins approach each other near the centre of the wing, and are connected by a cross-vein. The wing is heavily fringed with hairs, those on the under border—especially near the tip—being about three times the length of those on the costal border; there are a few hairs at the tip of the abdomen. Several specimens of this insect are admirably preserved: although its parts are so minute that the outline of the under wing can only be determined by the microscopic hairs upon its border, the insect can be completely restored from two or three individuals. I have proposed for it the name of *Palæothrips fossils.*

The specimens from the two localities differ so completely as to awaken the suspicion that the rocks of one locality may be older than those of the other. In both places, *Mycetophilidæ* and other *Diptera* are found, but, in Fossil Cañon, the variety and abundance are proportionately greater. The Ant, the Moth, the *Thrips,* and nearly all the small *Coleoptera* are restricted to Fossil Cañon, while the larvæ come from Chagrin Valley.

Perhaps no general conclusion can be drawn from this small collection, particularly as there is a total absence of means of comparing it with fossil insects of a similar age in this country; yet, while it does not agree in the aggregation of species with any of the insect-beds of England or Southern Europe, nor with those of the Amber fauna, there can be little doubt that it belongs to the Tertiary epoch.

We close with a few statements relative to the eighty-seven species mentioned in the previous pages. Six of them are from the Devonian Formation; fifteen from the Carboniferous; one from the Trias; and sixty-five from the Tertiaries. Ten are *Coleoptera*: viz., one from the Trias and nine from the Tertiaries; four are *Orthoptera*, all from the Carboniferous; nine are *Neuroptera*, viz., six from the Devonian and three from the Carboniferous. Five more, either *Orthoptera* or *Neuroptera*, are from the Carboniferous. Three are *Hymenoptera*, forty-five are *Diptera*, six are *Hemiptera*, all from the Tertiaries. Three are *Lepidoptera*, viz., one doubtful from the Carboniferous and two from the Tertiaries, one of which is also doubtful. Two are *Myriapoda*, both from the Carboniferous, but one of doubtful character. No spiders have been found fossil in America.

From this it appears that the *Diptera*, *Hemiptera*, *Hymenoptera*, and *Lepidoptera* (omitting the doubtful ones from Illinois) are restricted to the Tertiaries; the *Coleoptera*, with one Triassic exception, to the same; the *Orthoptera* and *Myriapoda* to the Carboniferous; while the *Neuroptera* are found in both the Devonian and Carboniferous formations.

BOSTON, U.S., *November 25th*, 1867.

NOTICES OF MEMOIRS.

I.—MR. DAVID FORBES' RESEARCHES IN BRITISH MINERALOGY.

MR. FORBES has published in recent numbers of the "Philosophical Magazine" a series of papers, in which he proposes to record, from time to time, the results of his investigations in British Mineralogy. In these communications it is his intention, to use his own words, "besides treating of the physical character and chemical composition of the minerals under consideration, to pay especial attention, whenever it is practicable, to their association, paragenesis, and mode of occurrence, as connected with the petrology and geology of their localities, in order thereby to elucidate, as far as possible, the origin and formation of the rock-masses, or mineral veins, in which they may happen to be imbedded." Before proceeding to the task in question, he devotes some attention to the present position of this branch of science in the United Kingdom, and finds that, though the labours of British mineralogists in the first third of the present century gained for British science a position "of which the country might well be proud," the advances which have since been made are mainly due to the researches of Continental inquirers. This unsatisfactory state of things he ascribes to the superior attraction of palæontology on the one hand, and organic chemistry on the other, and fears, moreover, that the British geologists of the present day often undervalue the importance of a knowledge of mineralogy for the successful prosecution of petrological investigations. Speculations are made on the chemical changes which our rock-masses have undergone before we are in possession of accurate data respecting the mineralogical character and chemical composition of the rocks themselves. "Only very few chemical analyses of British rocks have been made," and it is humiliating to learn that, "in this respect, England stands far behind the rest of Europe; France, Germany, Russia, and even the small kingdoms of Norway and Sweden are far in advance with regard to the knowledge of the chemical and mineralogical composition of their rocks." Through the absence of exact information on this important subject, the nomenclature at present used by petrologists "is altogether inadequate to the demands of the more advanced state of the other branches of geological inquiry; in geological surveys and maps it is common to find eruptive rocks of totally different mineral and chemical composition and age confounded with one another, and, in other cases, to find rocks coloured and described by names that do not pertain to them. In fact, the present state of classification and nomenclature of the eruptive rocks is such that it becomes impossible to know with any certainty what exact rock may be intended or mapped under the names generally in use." The science of mineralogy, as expounded in text books, is too apt to be considered merely to treat of the physical, chemical, and crystallographic characters of mineral species, and to end here. "The study of their mode of occurrence, association, and paragenesis, as well as of their origin and the relations which they bear to the geology of the matrix in which they are embedded, is one of the highest importance and interest to the mineralogist." These considerations are generally neglected, and it has become customary to regard the presence of minerals in rock masses as accidental, and to shirk the question of their origin. It is evident, however, their presence is due, not to chance, but to the operation of definite laws; and to this important subject the author directed his attention. His researches have led him to certain general conclusions, which are given. "Excepting only the smaller number of species which make up the bulk of rock masses in general, it was found that most other minerals when occurring in eruptive rocks, even when met with in the most widely separated parts of the globe, present themselves under similar conditions, have the same associated minerals along with them; and that the eruptive rocks in which they occur, whenever the age of their intrusion could be satisfactorily ascertained, frequently, if not always, corresponded in geological chronology." In the eruptive rocks by far the greater number of mineral species have been found; and in all parts of the globe the same or very analogous minerals are, as a rule, found to accompany the outbursts of similar eruptive rocks. Far, therefore, from regarding the appearance of minerals in eruptive rock-masses as accidental or extraneous, the author holds that more extended and accurate investigation will demonstrate, that, in like manner as the occurrence of certain fossils or groups of fossils enables the geological age of a sedimentary bed to be deduced, so will the presence of certain minerals, or classes of minerals, serve as a means of identifying the contemporaneous intrusions and outbursts of the eruptive rocks, which, at different geological epochs, have disturbed the earth's external crust." It was, likewise, observed that "whenever the same mineral is present in two or more rocks of different geological age, it is usually, if not invariably, characterised in each case by certain peculiarities, either in physical structure or chemical composition, which serve to distinguish it under the different circumstances of occurrence." This is shown to be true of felspar, mica, augite, garnet, apatite, hornblende, etc. In short the minerals generally regarded as accidental and extraneous, oftentimes form the real characteristic of the rock-masses containing them.

The author's labours on this important question have been greatly retarded by the great scarcity of facts which were found available. This is principally due to the neglect of mineralogists to record in their description of minerals their mode of occurrence, their mineral association, and the nature and age of the rock in which they are imbedded, as well as to the want, already mentioned, of chemical analyses of many of even the most common British mineral species. Of the 306 British species and sub-species described in one of the most recently published manuals of mineralogy of the British Islands, 164 have not yet been examined; and, it would scarcely be believed, that amongst these are included such minerals as hornblende, augite, orthoclase, labradorite, chlorite, talc, garnet, tourmaline, olivine, epidote, serpentine, beryl, etc. Moreover, our present knowledge of the composition of British rocks is of an equally unsatisfactory kind. "May it not now be fairly asked whether the natural inference to be deduced from these facts is not, that it is high time for British mineralogists and geologists to set to work, in order to supply these deficiencies before occupying themselves in propounding vague theoretical explanations, to account for the origin and metamorphosis of rocks in the field?" In the author's papers are given a description and analyses of the following British minerals.

Gold from the Clogau Quartz Lode, No. 2.—The lode occurs in the Lower Silurian Lingula beds, close to their junction with the Cambrian strata of the Geological Survey; it runs about 18° north of east, and dips at an angle of 88° to south, cutting through both fossiliferous strata and the intruded diabases, which are described as greenstones in the Survey; and it is, consequently, of later geological age than both these rocks, and is not improbably younger than the Silurian formation as a whole. The explorations appear to indicate that the lode is more auriferous at the parts where it cuts through the Lingula beds, with their accompanying diabases, than at greater depth where it traverses the Cambrian grits. Among the accessory minerals found in the lode are tetradymite, iron pyrites, chalco-pyrite, galena, chlorite, calcite, dolomite, chalybite, and heavy spar, which, as well as the gold, are distributed very irregularly in the quartz. When the quartz contains calcite, dolomite, and chalybite, or includes fragments of neighbouring clay-slate, it is regarded as likely to be more auriferous than when the lode consists of quartz only. When isolated fragments of the slate are found in the quartz of the lode, the gold and other metallic minerals are commonly found adhering to or crystallizing on their under surfaces, which may have arrested these minerals in the act of being carried into lode-fissure from below with the stream of liquid quartz. The specific gravity of one specimen of gold was found to be 17·26, and two analyses showed the per-centage composition of gold 90, silver 9·25, the remainder being quartz. These numbers closely agree with the formula $Au_6 Ag$. Another alloy, lighter in colour and probably richer in silver, is sometimes met with in the lode.

Stream Gold from the River Mawddach.—A specimen of the dust washed from the bed of the river near Gwynfyndd, some eight miles from Dolgelly, contained small, flattened, elongated spangles of gold, the largest having the size of a pin's head, accompanied by abundance of fine black sand, supposed to be magnetite, but found to be titanoferrite, together with some small particles of quartz, slate-rock, mica, iron pyrites, and galena. The gold was found to have a specific gravity of 15.79, and the following composition: gold 84·89, silver 13·99, iron 0.34, and quartz 0·43. Several spangles had a peculiarly rich yellow colour due to a thin film of sesquioxide of iron adhering to their surface.

Titanoferrite.—The basaltic or doloritic rocks of the South Staffordshire coal-field invariably contain a small amount of a heavy black metallic mineral, strongly attracted by the magnet, and generally regarded as magnetic oxide of iron, whilst analysis showed it to be titanoferrite. Removed from the pulverised rock by means of a magnet, it was found, on examination, to have a specific gravity of 4·69, and a composition closely approximating to the formula $Fe_2 O_3 Ti O_2$. The associated minerals, distinguishable only in thin sections when viewed under the microscope, are a triclinic soda-lime felspar, augite, and a small quantity of what is probably seladonite, whilst pyrites, apatite, and a zeolitic mineral are likewise occasionally present. An examination of specimens of these basaltic rocks from each eruptive boss in Staffordshire, as well as others from the intrusive masses occurring in coal-pits, showed that titanoferrite is invariably present, and is consequently an essential constituent of the rock itself. It is, moreover, that variety of titanoferrite, which usually accompanies the eruptive rocks of Palæozoic age. The presence of titanium not only serves to characterise the basalts of this district, but likewise affords a means of detecting these rocks where altered by metamorphic action, and of referring tuffs, clays, etc., formed from them, to the original source. Two instances furnishing proofs of this are mentioned.

Polytelite from the Foxdale Silver Lead Mine, Isle of Man.—This mineral has been found in quantity sufficient to make it an object of commercial consideration. The lode wherein it occurs cuts through both the Lower Silurian and the eruptive granite; the latter appeared subsequent to the deposition to these beds, and is identical in its mineralogical character with the auriferous granites of other parts of the globe. The minerals associated with the polytelite are galena, chalcopyrite, iron pyrites, zincblende, quartz, dolomite, chalybite, and calcite. The characters of the mineral itself are as follows: massive; opaque; lustre metallic; colour brown-black; streak black to brown-black; fracture sub-conchoidal, uneven, and granular, brittle; powder black; hardness, 3·5, scratching calcite, but not fluor; specific gravity, 4·97. Analysis led to the following numbers: sulphide of silver, 15·67; sulphide of antimony, 34·82; sulphide of copper (Cu S), 34·26; sulphide of iron, 7·57; sulphide of zinc, 7·18; and sulphide of lead, 1·66. These results differ but little from the composition of specimens of polytelite from other localities to which the formula $4\ (Cu_2,\ Ag,\ Fe,\ Zn,\ Pb)\ S,\ Sb\ S_3$ is attributed; it appears not unlikely, however, that in such metallic sulpho-salts the copper may really be in the form Cu S.

Polytelite from the Tyddynglwadis Silver Lead Mine, N. Wales.—This mine lies in the valley of the river Mawddach, near Dolgelly, and is close to the junction of the Cambrian rocks with the Lower Silurian Lingula beds, the main lode cutting through the Menevian group with its associated diabases. The polytelite is disseminated in the lead ores of this mine, and was with difficulty isolated in sufficiently pure a condition for analysis. Its associated minerals are native gold, native silver, galena, chalcopyrite, blende, iron pyrite, arsenical pyrites and quartz. Assays showed the polytelite to contain 11·25 per cent. of silver. In the washing of the ores of this mine it had been noticed that the lighter slimes were the richer in the precious metals, which the author imagined to be due to the greater part of the silver occurring in the form of polytelite (specific gravity 4·8), and not as a constituent of the galena (specific gravity, 7·7). He succeeded, by careful washing, in separating the metallic portion of the powdered ore into two layers, the lighter in which was most of the polytelite, containing 182 ounces of silver per ton, and the denser, consisting of argentiferous galena, yielded 60 ounces of silver per ton.

Sulphides of Iron and Nickel.—The sulphide of iron and nickel from the nickel mine, near Inverary Castle, Argyllshire, possessed the following characteristics: massive; fracture between granular and semicrystalline; brittle; opaque; lustre metallic; colour, light bronze-brown; hardness, 3·5; strongly magnetic; specific gravity, 4·5. It was composed of 38·01 per cent. sulphur, 50·66 iron, and 11·33 nickel; and is probably to be regarded as composed of Millerite and pyrrhotine. Some specimens of nickeliferous pyrrhotine from this mine are studded with brass-yellow spots resembling iron pyrites, and after the lapse of some years the double sulphide becomes disaggregated, whereby the separation of the yellow mineral can be effected. Its specific gravity was found to be 4·93, and its composition: sulphur 43·32, iron 45·73, nickel 1·99, cobalt 1·24, copper, 1·18. The iron pyrites appears to have segregated out of the general mass, carrying with it the cobalt and copper, scarcely a trace of cobalt being found in the pyrrhotine; and there appears to be a tendency on the part of cobalt to associate itself with bisulphide of iron, whilst nickel appears to prefer uniting itself with the magnetic sulphide. A chemical examination of several hundred specimens of iron pyrites and magnetic pyrites taken from mineral lodes and eruptive rocks, proved that nickel was very rarely found in iron pyrites, when unaccompanied by pyrrhotine, but that cobalt was very commonly present in small quantity,—and, on the other hand, that cobalt was equally seldom present in magnetic pyrites if unaccompanied by iron pyrites,—also that when both these metals were present in a specimen of pyrites, the nickel greatly preponderated when the pyrites in question was magnetic, whilst the reverse was found to be the case in the ordinary iron pyrites. A specimen of sulphide of iron and nickel from the Craigmuir mine, near Inverary, was likewise examined. The lode in this district traverses metamorphic strata, and is disturbed by intersecting trappean dykes. The characters of this mineral agreed closely with those of the specimen already mentioned, its specific gravity was 4·602, and its composition: sulphur 37·99, iron 50·87, nickel 10·01, and cobalt 1·02.

Gersdorffite from the Craigmuir Nickel Mine, near Inverary.—This mineral occurs in a small string or cross-course intersecting the main lode of sulphide of iron and nickel. The specimen examined was a compact aggregate of minute indistinct crystals along with quartz and a talcose mineral. In places, patches and strings of copper pyrites were visible, but little or no sulphide of iron and nickel occurred with it, although this last-mentioned mineral formed the mass of the lode. The characters of the mineral are as follow: crystallized; opaque; lustre metallic; colour, white to greyish white, tarnishing to a greyish-brown tinge; streak, black; powder, blackish grey; fracture, granular; brittle; hardness, 3·75, rather below fluor spar; specific gravity of two specimens, 5·65 and 5·49. The percentages of the analyses accord with the formula $\mathrm{Ni\ (S\ As)_2}$, and show the British mineral species to bear a resemblance to the crystallized specimens from Schladming in Styria.

II.—THE BONE-CAVES OF BRAZIL AND THEIR ANIMAL REMAINS.

By Professor REINHARDT.

THIS distinguished author, well known to zoologists by his numerous and valuable contributions to the history of Mammals (especially *Cetacea*), Birds, Reptiles, Fishes, etc., has favoured one of the popular scientific journals[1] of his country with a detailed and very interesting account of "The Bone-Caves of Brazil and their Animal Remains;" a subject on which Professor Reinhardt, through his repeated travels in that country, and his familiarity with its recent and Post Pliocene fauna,[2] must be regarded as one of the first authorities. In the hope that one of the many popular scientific reviews and journals of England will give its readers the pleasure of becoming acquainted with his memoir *in extenso*, through a translation, we shall here restrict ourselves to giving in the author's own words the general conclusions with which he sums up the most important results of his careful studies on the subject.

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[1] Tidschrift for populare Fremstillinger af Naturnidenskaben, udginet af C. Togh az C. Lütken, 1867.

[2] Dr. P. W. Lund's collections from the Brazilian Caves in the Museum of Copenhagen are entrusted to the care of Prof. Reinhardt.

"1. During the Post Pliocene epochs, Brazil was inhabited by a very rich Mammalian Fauna, of which the recent one might almost be said to be a mere fraction or a crippled remnant, as many of its genera, even families and sub-orders, have vanished, and very few been added in more recent times.

"2. During the whole Post Pliocene epoch the Brazilian Mammalian Fauna had the same peculiar character which now distinguishes the South American Fauna, compared with that of the Old World; the extinct genera belonging to groups and families, that to this very day are peculiarly characteristic of South America. Only two of its genera, the one extinct (Mastodon), the other still living (the Horse), belong to families that in our epoch are limited to the Eastern Hemisphere.

"3. All the Mammalian orders were not in the same degree richer in genera in former times than now. The Bruta, Ungulata, Proboscidea, and, lastly, the Feræ, have relatively suffered the greatest losses. Some orders, for instance the Chiroptera and Simiæ, number perhaps even more genera now than formerly.

"4. The Post Pliocene Mammalian Fauna of South America differed much more from the modern one, and was especially more rich in peculiar genera, now extinct, than the corresponding fauna of the Old World.

"5. The scantiness of great Mammalia—one might say the dwarf-like stamp impressed upon the South American Mammalian Fauna of our days, when compared with that of the Eastern Hemisphere, was much less observable, or rather did not exist in the prehistoric Fauna. The Post Pliocene Mastodonts, Macraucheniæ, and Toxodonts of Brazil, its many gigantic Armadillos and Sloths could well rival the Elephants, Rhinoceros, and Hippopotami, which during the same period roamed the soil of Europe." X.A.

REVIEWS.

NOUVELLES RÉCHERCHES SUR LES ANIMAUX VERTÉBRÉS DONT ON TROUVE LES OSSEMENTS ENFOUIS DANS LE SOL ET SUR LEUR COMPARAISON AVEC RES ÉSPÈCES ACTUELLEMENT EXISTANTES. Par PAUL GERVAIS. 1re. série. Illustrated by 50 plates and numerous woodcuts. Arthur Bertrand, Paris, 1867. 4to.

THIS work, of which we have the first five numbers before us, is announced to be completed in thirteen parts, each of 24 pp., accompanied by four lithographic plates and woodcuts.

The first division of the work treats of the Antiquity of Man and the Quarternary Period

After giving a short history of the opinions that have beeen expressed since the attention of geologists was first turned to this subject, the author recounts some of the discoveries which led scientific men to suspect the co-existence of man with the larger, and long since extinct, Mammalia of the Pleistocene epoch.

In the first chapter, M. Gervais discusses the value of the different proofs of the existence of prehistoric man in Western Europe, *e.g.* fossil human bones, flint and bone implements, many of the latter being made of the bones of extinct animals, that had evidently been cut when in a fresh state, and on some of which were drawings of the Mammoth, Reindeer, and other animals long since extinct, or which had migrated from these regions in prehistoric times, and whose remains are found associated in the Quaternary deposits and caves of France and England, etc.

Next comes an account of the "Palafittes" or Swiss lake-habitations, the newest of which, our author thinks, approach very near to historic times, and do not date back more than 2000 years (just at the commencement of the Bronze Age), the earlier ones, however, belonging to the Stone Age.

In talking of the Bronze Age, a curious mistake occurs, for M. Gervais says the Phenicians came as far as *Scotland* to seek one of the elements of this alloy, which surely must be a misprint for Cornwall (Part 2, p. 29).

Full descriptions of the implements and human animal remains, as well as a long list of the plants found in the Lake-habitations, are given.

The second chapter is on the deposits of the Quaternary Period, and their division into four epochs, in all of which flint implements are found, but which are palæontologically distinguishable by means of the animal remains occurring in them.

1st. *The Epoch of Elephas meridionalis,* which he considers indisputable since the discovery of worked flint at St. Prest. *E. meridionalis* is considered in England to characterize an epoch *antecedent* to man's appearance in Western Europe. If found with human implements at St. Prest, we may yet hear of the discovery of flint implements in the Norfolk Forest bed. M. Gervais admits that it is difficult to separate this period from the

2nd, *The Epoch of Elephas primigenius*; having the Mammoth for its principal species, also the Great Bear, the Hyæna, and the Cave Lion, etc.

3rd. *The Epoch of the Domestic Reindeer.*

4th. *The Epoch of the Lake-dwellings.*

Then follow descriptions of the Osseous Breccia of Montpellier, etc.

Chapter III. contains minute descriptions of caverns which M. Gervais has himself explored. They are mostly situated near the centre of France and in Lower Languedoc. He commences with Roca-Blanca, near Cabrierès, Hérault, one of the most modern. Here several human skeletons have been found; the skulls are of the *brachycephalic* type, and associated with them are bones of sheep, pigs, rabbits, and a small race of oxen.

2nd. Cavern of Baillargues, near Castries (Hérault).

3rd. Pontil, near St. Pons (Hérault), in which were found, along with a human frontal bone, a canine tooth of *Ursus arctos* split longitudinally and pierced near the base; the jaw of a beaver, various instruments formed from bones of rhinoceros (*Rh. Merckii?*) ox (*Bos primigenius*), fox, badger, from teeth of horse, of stag's horn, and terra-cotta, which apparently belong to the age of the Swiss Lake-habitations; handles made of horn for flint implements, and some stone implements. Five plates are devoted to the contents of this cavern, and the figures are of the natural size. Here were also found some instuments of the Bronze and even of the Iron Age, and a fibula of silver; but these latter had apparently fallen in at a superior opening.

4th. Several caverns in the neighbourhood of Ganges (Hérault). In which were found flint implements, bones of man, ox, and goat; teeth of fox, pierced by man; two valves of the common mussel, bones of *Ursus spelæus*, *Cervus elaphus*, and *Capra ægagrus* that had evidently been fractured by man.

5th. Cavern of Bize (Aude). Bones of *Equus caballus*, *Bos primigenius*, *Capra ægagrus*, *Antilope Christolii*, *Rupicapra*, *Cervus Reboulii*, *C. tarandus*, *Canis lupus*, *C. vulpes*, *Felis sevaloides*, *Ursus spelæus*, *Hyæna spelæa*, embedded with human remains and implements made of stone and of the bone of many of the above animals, together with the following shells:—*Pectunculus glycimeris*, *Pecten jacobæus*, *Mytilus edulis*, *Buccinum reticulatum*, *Natica mille-punctata*, *Turbo neritoideus*, *Clyclonassa neritæa*, *Cypræa coccinella*, some of which had been perforated by man.

6. Caverns of Mialet, etc. (Gard), where occur bones of *Felis antiqua*, in addition to those mentioned before, and *Antelope Mialeti*.

Chapter IV. contains remarks on Rhinoceros and a few other genera of Pleistocene mammals, having reference more especially on the identity of their species, and on what has been recorded about them by other palæontologists.

Chapter V. gives an account of the fossils of Algeria, and a comparison of the Quaternary mammals with those of Western Europe, and their living representatives in Central Africa.

In Chapter VI. the reader is furnished with an account of all the known mammals of the Quaternary period, and the localities where the remains of the rarer species have been met with.

OUR SCIENTIFIC AND POPULAR JOURNALS.

I. The Popular Science Review (No. 27) for April contains, in addition to much other interesting scientific matter, an excellent and most instructive article on "The Gems and Precious Stones of Great Britain." By Professor John Morris, F.G.S., of University College.

After giving a brief historical account of the uses to which precious stones are applied by Oriental races, and of the traditions connected with various species of gems, the author proceeds to describe those which occur in the British Islands,—*e.g.* the garnet, topaz, beryl or emerald, sapphire(?), and the varieties of amorphous and crystallized quartz, as rock-crystal, amethyst, cairngorm, agate, onyx, calcedony, jasper, opal, etc. In Great Britain these are generally found embedded in the rock-mass, whilst the valuable and most highly prized stones, which come to us from abroad, are rarely obtained from the original matrix, but are usually found as grains or pebbles in ancient or modern alluvial deposits, the more perfect and solid ones only having resisted the wear and tear to which they have been subjected since they were set free by the breaking up of their parent rocks. Hence the comparative abundance of the precious stones in the river-valleys of India, Ceylon, Australia, and South America, which traverse the metamorphic strata in which these minerals were originally imbedded.

Of the gems and precious stones found in Great Britain, by far the largest class are compounds and varieties of silica, which owe their beauty as gems, in many instances, to the presence of an infinitesimal quantity of some metallic oxide, as manganese, iron, chromium, etc., thus producing those beautifully coloured stones, the emerald, amethyst, cairngorm, etc., so extensively used in jewelry.

In speaking of the Beryl, at page 130, we observe a misprint, which might, if passed over, mislead the reader. It is there stated that "Beryl is *harder* than Topaz." On referring to the "Table of Physical Characters of Gems," given on page 133, however, we find their relative hardness correctly stated thus (placing the hardness of the Diamond at 10):—Topaz = 8; Beryl = 7·5.

This article will be found most instructive, both historically and mineralogically—the Chromolithographic plate which accompanies it is not, however, so good in its way as those to "Reynaud's Histoire Elementaire des Mineraux Usuels" (see GEOL. MAG. Vol. IV. 1867, p. 555).

II. THE QUARTERLY JOURNAL OF SCIENCE (No. 28) for April, particularly recommends itself to our notice by a most valuable paper by Professor Dr. G. Zaddach, of Königsberg, on "Amber, its Origin and History, as illustrated by the Geology of Samland" (Prussia). The age of the "Glauconitic sand" deposit, which yields this interesting and valuable fossil Resin, is of Eocene or Lower Oligocene age, according to Mr. C. Mayer, of Zurich; but the associated fossils are marine Mollusca, Echinoderms, and Polyzoa; and the Amber is usually, more or less, rounded and water-worn, the associated fossil-wood being generally only found in small pieces apparently half-decayed at the time of their deposit. Dr. Zaddach devoted himself therefore to the task of ascertaining the probable position of the old land-surface, upon which the Amber-pines grew, that furnished this rich deposit, yielding, on an average, ½-lb. to 1lb. of Amber to every cubic foot of sand. Searching for and examining with care all the pebbles and fragments of rock which occur in the "Amber-earth," and tracing these to the parent-rock, he shows that the Tertiary "Glauconitic sand" has been formed out of the waste of the Greensand where that deposit reposed on old Silurian rock and he traces the derivation of both the Silurian pebbles and Greensand to the waste of the old high lands of Northern Europe, consisting of the crystalline rocks of Scandinavia and Finland and the Silurian, Devonian, and Cretaceous strata, once extending from Scandinavia over the area now occupied by the northern part of the Baltic and its bays through Courland and Esthonia far away eastwards.

The trees of this old northern land appear, nevertheless, to have enjoyed a temperate climate, elevated probably by a warm marine current from the tropics. Thus Camphor-trees, Willows, Beeches, Birches, and numerous Oaks occur, together with Pines and Firs, in great variety, and amongst them the Amber-pine. In order to account for the richness of the Amber deposit, Dr. Zaddach assumes that many thousands of this last-named tree must have perished, and the amber-gum accumulated in vast quantities in the soil previous to the submergence of the land.

A detailed account of all the beds is given, including a description of the more modern Brown-Coal Formation, the trees of which nearly agree with the existing European flora.

A good map of the North-west Coast of Samland, with numerous sections, and also a plate of Fossil Insects found in Amber (determined by Mr. Frederick Smith, of the British Museum), together with a list of authors who have written on the subject, completes this most useful and valuable memoir.

III. The Intellectual Observer having remained single for six years, has become tired of celibacy, and this being leap-year, has wedded the "Student," by which name it will be in future known. Mr. Jackson writes in No. I, February, on "The Screw-Pine" (*Pandanus*) and its allies. (For a good account of the fossil *Pandaneæ* see Mr. Carruthers' article in Geol. Mag. for April last, p. 153, Pl. IX.)—Mr. Shirley Hibberd, about *Ailantus* silkworm culture;—Mr. J. K. Lord on the Rocky Mountain Goat.—Mr. Thomas Wright (in Nos. 1, 2 and 3), on Womankind in all ages: he has not, at present, touched upon Pre-historic ladies, when he does, however, we shall take care to call attention to the fact.

In No. 2, Mr. Jackson informs us that the fine old patriarch of the vegetable world, "The Dragon-tree" of Teneriffe, computed by some authorities to be six thousand years old, fell a victim to a furious gale which swept across the Island last autumn. Humboldt describes it as 45 feet in circumference a little above the root, and Sir George Staunton as 12 feet in diameter, 10 feet from the ground, and its height 70 to 75 feet. Fossil wood from the Iguanodon Quarry near Maidstone has been attributed to this genus (*Dracæna Benstedii*, Kōnig.)

In No. 3, Professor Church gives us an account of "Turacine," a new animal pigment containing copper obtained by him from the red feathers of the "Touraco," or "plantain-eater." It is not a little singular that this red colour is instable in the wing of the living bird, and can readily be removed by washing the feather. Three birds —two species of Plantain-eaters and one Musophaga—have yielded this compound of copper. The birds are from the Cape, Natal, and the Gold Coast. There is also, among many others, an important and valuable paper by the Rev. W. Houghton, M.A., F.L.S., on *Holothuriæ*, or Sea-cucumbers, soft-bodied vermiform Echinoderms, much sought after as microscopic objects, on account of the beautiful calcareous spiculæ which are found in the skin. Being soft-bodied, their occurrence in the fossil state is always doubtful, although some instances are on record. One of the plates is very nicely executed.

REPORTS AND PROCEEDINGS.

Geological Excursion to Bath and its Neighbourhood.—The students attending the Geological class at University College, London, made an excursion to Bath with the view of acquiring some practical lessons in field geology. They were accompanied by Professor Morris, Mr. D. Forbes, Mr. Beale, Dr. Murie; and were met at Bath by Mr. C. Moore, F.G.S., whose intimate knowledge of the Geology of Somersetshire materially assisted their researches, as that gentleman kindly accompanied them to all the most important geological localities.

Bath is well situated for geological exploration, as not only are there many well-exposed sections, but the physical features of the district afford striking evidence of the denuding agencies to which the whole area has been subjected, and from which has resulted—owing to the characters of the rocks—the picturesque scenery of the district. The sections around Bath afford good opportunities for studying the Lower Oolitic strata—*i.e.* the Lower, Middle, and Upper Lias, the Inferior Oolite, Fuller's earth, and the different beds of the Great Oolite,—all of them shewing the very different conditions under which they have been deposited. This is well marked in the Bath Oolite series, where the comparatively finer stone, known as the Bath freestone (an Oolitic rock largely worked and used for building both there and elsewhere) is well distinguished from the upper coarse shelly limestone containing corals, sponges, and Bryozoa, and frequently presenting false-bedding due to ancient current action. It is to the alternation of these hard and soft strata that the terrace-like appearance of the valleys is due; while, at the same time, their alternate permeable and impermeable nature are the sources of the water-supply of the neighbourhood, as seen in the springs bursting out at the top of the Fuller's earth and Liassic beds—an arrangement which W. Smith availed himself of, in laying out the canal system of the Oolitic districts—these clay beds presenting also, more or less, sloping banks and irregular ground. The bottom of the valleys near Bath are filled to some height with an old alluvium termed "Mammal drift," containing remains of the Mammoth (*Elephas primigenius*) and the Musk ox (*Ovibos moschatus*), etc.

The railway now making from Bath to Mangotsfield, near Weston, afforded the party some new and highly interesting sections; one about two miles out, exposed the Rhætic strata, with so-called Cotham Marble, White Lias, and "Sun-bed," with few fossils, overlain by the *Ammonites angulatus*, and *Bucklandi* beds, containing many fossils, noticed by Mr. Moore,[1] the section presenting two faults or displacement of the rocks. Not far distant is the Twerton Coal-pits sunk through the overlying but unconformable lower Secondary strata of no great thickness; and it was interesting to observe close to the pit's mouth another fine stone quarry in the *Am. Bucklandi* beds overlying the probable equivalents of the *Am. planorbis* zone,[2] the former containing the characteristic *Lima gigantea*, *Gryphæa incurva*, *Nautilus lineatus*, *Pleurotomaria Anglica*, etc., and consisting of thick-bedded limestones, with intercalated shaly bands, some containing Foraminifera. In the uppermost portion of the *Am. Bucklandi* beds of this pit is a thin band of brown indurated marl, indicating a persistent horizon at the top of the series throughout the district. It contains many plants and remains of fishes (*Hybodus*, *Acrodus*, *Lepidotus*, etc.,) as well as *Avicula inequivalvis* and other shells.

A section on the same railway near Saltford afforded a fine exposure of the *Am. Bucklandi* bed with the associated fossils, showing bands of tabular and septaroid limestone, the latter frequently containing large Ammonites, while fissures were lined with beautiful crystals of brown calcite, presenting both the dog-tooth and rhombohedral forms, as well as modified octohedrons of pyrites. The Ammonite is found here in the same condition as the large one originally obtained by Dr. Buckland from the neighbourhood, having lost the inner whorls, which enabled the Doctor to thrust his head and shoulders through, and thus he rode home, dubbed by his friends the *Ammon Knight*, encircled with the species which now bears his name (Sow. Min. Con. 2, p. 69).

The party visited, on the railway above-mentioned, at Willsbridge, another fine section, showing the curved strata of the Red Marl, Rhætic beds, and Lower Lias faulted against a mass of Pennant rock, or sandstone, deeply ferruginous at the junction, but further on intercalated with carbonaceous layers and bands of red Hematite. The conditions of this section are very instructive, as at the south end is seen the Red marl with greenish bands, and nodules of celestine (sulphate of strontian) superposed by a fair development of the Rhætic series with the *Avicula contorta* zone, *Estheria* and *Cythere* shales and White Lias, with *Modiola*, overlain by the *Am.*

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[1] Geol. Journal, vol. xxiii. p. 497.

[2] The term *zone* is applied to a subdivision of Lias strata characterized by the abundance of a peculiar Ammonite and associated fauna, but which are not entirely restricted to that zone. The following are the subdivisions of the Lias, shewing the Ammonite zones:—

UPPER LIAS	*Am. Jurensis*	LOWER LIAS	*A. raricostatus*
	A. communis		*A. oxynotus*
MIDDLE LIAS	*A. spinatus*		*A. obtusus*
	A. margaritatus		*A. Turneri*
	A. capricornus		*A. Bucklandi*
	A. ibex		*A. angulatus*
	A. Jamesoni		*A. planorbis*

Bucklandi beds with the characteristic fossils.[1] These beds, as you ascend the hill sides above Bitton, are successively overlain by the Middle and Upper Lias, and the sands of the Inferior Oolite.

Another day the party visited—after passing a narrow strip of Old Red Sandstone at Spring Garden, north of Frome—the fine sections of the Vallis, where, at Hapsford Mills, the upturned and denuded edge of the Carboniferous Limestone are immediately overlain by a thick bed of conglomerate; the rounded pebbles, many of limestone, being sometimes bored and occasionally having oysters attached to them. This bed is covered by more quietly deposited strata of marl and shale, with nodules containing *Estheriæ*; further on a fault is observed bringing down the Inferior Oolite, beyond which the limestone contains a kind of mineral vein, which becomes far more numerous as you proceed up the valley, and more interesting from the fossil contents, consisting, (as shown by Mr. Moore,) of Liassic strata, partly filling the fissures, to the walls of which Lias fossils are adhering, associated with concretionary ferruginous bands of Sulphate of Barytes, some Galena and Blende. In this valley at the southern corner the Inferior Oolite is laid down upon the ancient Carboniferous Limestone sea-bottom, and has so accommodated itself to any inequalities in its surface as to make it exceedingly difficult to determine where the one formation begins, or the other ends. So intimately united are the unconformable deposits, that the same hand-specimen may show portions of each, with *Lithodomi* of Oolitic or any intervening age, still retained in their burrows in the surface of the Carboniferous Limestone.[2]

The Nunney and Holwell sections were afterwards visited, showing the numerous Liassic veins in the Carboniferous Limestone, of various thicknesses, and containing many organic remains. Beyond this is the *Microlestes* quarry on the Shepton Mallet road,—a dyke in the limestone which has yielded such a rich harvest of Rhætic remains, including the mammal teeth belonging to the same genus (*Microlestes*), which was first found in deposits of similar age near Stuttgard. Besides the mammals Mr. Moore carefully examined some tons weight of the vein, extracting therefrom many remains of Reptilia (some new to England), *Nothosaurus, Placodus, Psephoderma, Ichthyosaurus, Plesiosaurus,* etc., and not less than 70,000 teeth of *Lophodus,* besides shells and corals, many of which are now exhibited in the Bath Museum. Above the hamlet of Holwell, on the Marston road, is a small section, in which the Carboniferous, Rhætic, Lias, and Inferior Oolite are represented, the last bed being unconformable.

The party concluded the day's excursion by a visit to a new trial sinking for coal on the estate of the Earl of Cork, near Iron Millbridge, which had reached the depth of eighty feet, in the Oxford-clay, showing the characteristic fossils, as *Gryphea dilatata,*

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[1] See the section by Mr. Moore, Geol. Journ., vol. xxiii. p. 499.

[2] De la Beche, Mem. Geol. Survey, vol. i. p. 290; Moore, Geol. Journ. vol. xxiii. p. 488.

Am. Jason, *Nucula*, *Avicula espansa*, and which had been thought to be of Liassic age.

Another excursion included a visit to Radstock, and the Mendips, passing along the table land of the Great Oolite, on Odd Down, the Fuller's earth was examined in a field cutting on the hill side, yielding many *Rhynchonella varians*, and other fossils. At Radstock, the White Lias and Lower Lias are fairly exposed, the zone of *Spirifer Walcottii*, with *Pholadomya* in their normal position was carefully examined, and it was interesting to observe that coal was won through these beds, owing, as is well known, to the comparative thinness of the Secondary strata in this area as compared with similar beds south of the Mendips, and their unconformity to the inclined and faulted Coal-measures below. Thus, according to Mr. C. Moore, the relative thickness in the two areas is as follows:[1]—

	Without Coal basin. feet.	Within Coal basin. feet.
Triassic beds	2000	50
Rhætic beds	50	50
Lower Lias	700	2
Middle and Upper Lias	500	42
Inferior Oolite...	170	25
	3420	169

Many fossil plants were collected, and the party had the pleasure to examine the fine collection formed by Mr. J. McMurtrie, consisting of *Lepidodendra*, *Sigillaria*, *Calamites*, *Asterophyllites*, and the ferns *Neuropteris* and *Pecopteris*; some specimens shewing the circinate vernation, others traces of fructification, but all in a state of preservation for which the Radstock Coal-field is celebrated.

Proceeding southward the Dolomitic conglomerate was seen near Stratton, and further on the outcropping of the Lower Coal-measures, the Millstone grit, and Carboniferous Limestone tilted up at a considerable angle; beyond this is the Old Red Sandstone, which there forms the crest of the Mendips, and at East End, near Stoke Lane, are portions of a dyke of considerable thickness, emerging from beneath the Old Red Sandstone, occurring as bosses in the field, but, traced for some distance over the district, it is conglomeratic in places, and pronounced by Mr. D. Forbes to be Dolerite.

This mass of igneous rock is considered by Mr. C. Moore to have been the cause of the elevation of many thousand feet of stratified rocks, and of the present anticlinal arrangement of the strata of the Mendips. Beside this, Mr. Moore inferred an old land-area, as originally suggested by Mr. Godwin-Austen, and that these hills in Rhætic and Liassic times interposed a barrier, which, to a great extent, modified the physical features of the whole line of country, from Frome through a great part of South Wales, and shut out the Secondary deposits from the Coal-basin, within which unconformability very generally prevails, and that the Secondary beds are very insignificant when compared with their equivalent deposits beyond.[2]

J. M.

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[1] Geol. Journ. vol. xxiii. p. 476.

[2] Geol. Journ. vol. xxiii. p. 537.

GEOLOGICAL SOCIETY OF LONDON.—I. February 26th, 1868.—Prof. T. H. Huxley, LL.D., F.R.S., President, in the Chair.

The following communications were read:—

1. "Notes on the formation of the Parallel Roads of Glen Roy." By C. Babbage, Esq., F.R.S. Communicated by the President.

Accepting the theory that these roads were formed on the margin of a lake, the author discussed the mode in which this formation took place, objecting to the view of its having occurred through the piling up of pebbles by wave action, or the accumulation of blocks by rain washing them down the hill-side.

Mr. Babbage expressed his opinion that the material of which the roads are formed was brought down by snow and ice slowly descending the hills until arrested on the margin of the frozen lake. On the melting of the snow and ice, it was tranquilly deposited without any further descent, and thus lay in a horizontal line.

In conclusion the author adverted to the theory of the change of isothermal surfaces within the earth, an account of which he had published in the Society's 'Proceedings' for 1834, as affording the necessary explanation of the causes which had produced the changes of climate in the district of the Parallel Roads.

2. "On the origin of smoothed, rounded, and hollowed surfaces of Limestone, and Granite." By D. Mackintosh, Esq., F.G.S.

The author endeavoured to show that smoothed, rounded, hollowed, and regularly-perforated surfaces of rock (not glacial, nor mere developments of structure), have been produced, on the Mendip Hills, by the action of waves charged with sand and stones; and that deeply-grooved rock-surfaces, near Minera, may have been ground out by stones moved by waves with or without coast-ice.

3. "On a striking instance of apparent oblique lamination in Granite." By D. Mackintosh, Esq., F.G.S.

In this paper the author drew attention to remarkable instances of apparent stratification and oblique lamination in the granite of the Hountor and other rocks of Dartmoor. They seemed to favour the aqueous origin of certain kinds of granite; though this Mr. Mackintosh left an open question.

4. "On the Encroachment of the Sea in the Bristol Channel." By D. Mackintosh, Esq., F.G.S.

The object of this paper was to show how the sea denudes a submerged land valley by planing it down laterally. Stumps of trees are found under the sea at a distance of at least half a mile from the cliffs near Watchet, with a rocky sea-bottom between. The latter must have been left by the erosive action of the sea, which, to the east of Watchet, has removed the site of a village called Easonton, and encroached at least 200 yards in 150 years.

5. "On the two Plains of Hertfordshire and their Gravels." By T. M‘K. Hughes, Esq., M.A., F.G.S.

The high ground near Hertford Heath, Brickendon, etc., forms the higher of the two plains which Mr. Hughes described; out of it a great valley has been excavated, the bottom of which forms the lower plain; and out of this again the valleys of the existing streams have been scooped,

The gravels of the upper plain are a marine deposit, and indicate a marine denudation of great antiquity, followed by an emergence, during which the old valleys were scooped out of that plain. The gravels of these valley-plains were formed during a subsequent submergence; they contain bands of clay and loam passing into Boulder-clay, and are probably marine. This submergence continued until the Boulder-clay was deposited on the top of the higher-plain gravels; and then succeeded a period of emergence, during which the present valleys were scooped out of the lower plain.

II. March 11th, 1868.—"On the Structure of the Crag-beds of Norfolk and Suffolk, with some observations on their Organic remains.—Part I. Coralline Crag." By Joseph Prestwich, Esq., F.R.S., F.G.S., etc.

The history of the division of the several Crag-deposits into three formations—the Mammaliferous, Red, and Coralline Crags—having been recounted, the author stated that for the last thirty years the evidence of their sequence had remained unaltered, the distinction between the Mammaliferous and Red Crags being still purely palæontological, not a single case of superposition having been discovered. Mr. Prestwich then proceeded to the special object of this paper, which was to describe more fully the physical structure of the several crags, and to determine, if possible, the exact relation which the Suffolk Crags bear to the Crag of Norfolk.

Commencing with the Coralline Crag, the author stated that the well-known outlier at Sutton furnishes a base-line and the best clue to its structure and dimensions, showing also the depth to which it has been denuded and replaced by the Red Crag. The Coralline Crag is generally described as consisting of two divisions:—an upper one, formed chiefly of the remains of Bryozoa, and a lower one of light-coloured sands, with a profusion of shells; and the author now gave their exact dimensions and his proposed subdivisions, as follows:—

	CHARACTER AND THICKNESS.	LOCALITIES.
Upper Division, 36 ft.	*h.* Sand and comminuted shells, 6 ft.	Sudbourne and Gedgrave.
	g. Comminuted shells and remains of Bryozoa, forming a soft Building-stone, 30 ft.	Sutton, Sudbourne, Gedgrave, Iken, Aldboro'.
Lower Division, 47 ft.	*f.* Comminuted shells, with numerous entire small shells, 5 ft.	Sutton, Iken, Orford, High Gedgrave.
	e. Sands with numerous Bryozoa, and some small shells and *Echini*, 12 ft.	Sutton, Broom Hill.
	d. Comminuted shells, large, entire, and double shells, and bands of limestone, 15 ft.	Sutton, Broom Hill, Sudbourne.
	c. Marly beds, with numerous well-preserved and double shells, 10 ft.	Sutton, Ramsholt.
	b. Comminuted shells and Cetacean remains, 4 ft.	Sutton.
	a. Phosphatic nodules and mammalian remains, 1 ft.	Sutton.

Mr. Prestwich then stated the localities at which these sub-divisions of the Coralline Crag are exposed, and proceeded to discuss the geographical distribution of the existing species in the several zones, and the present range of the organic remains. He agreed in the opinion that the greater number of the Mammalian remains are extraneous fossils; but regarded those of a whale as truly contemporaneous, and probably also the teeth of the *Rhinoceros* and *Mastodon*, while the bones that are more or less drilled he considered to be derived. The occurrence of a large block of porphyry in the basement-bed at Sutton was considered a proof that a considerable degree of winter cold had been attained at that period, as it would be difficult to account for its presence in that bed except by ice-action; the author also enumerated the physical conditions which seem to be suggested by the mineral character and the structure of the several zones, inferring, from the peculiar mixture of southern forms of life with others of a more northern type, that at this early period the setting-in of conditions of considerable cold had commenced.

With the aid of Mr. Gwyn Jeffreys, the author had revised the list of Mollusca from the Coralline Crag, and he gave a Table in which the range of the species in space, depth, and time was given, and an analysis of their synonymy by Mr. Jeffreys. He also discussed the relations of the Coralline Crag with its foreign equivalents, agreeing in the conclusion that the Crag Noir is a stage older than it, while the destruction of beds of the age of some of the older Crags of Belgium have furnished many of its derived fossils. In conclusion the author described the distribution of sea and land at the period of the deposition of the Coralline Crag, as suggested by the affinities of the fossils of that deposit.

III. March 25th, 1868.—1. "On some new species of Palæozoic Crustacea from the Upper Silurian rocks of Lanarkshire, etc., and further Observations on the Structure of *Pterygotus*." By Henry Woodward, Esq., F.G.S., F.Z.S.

The nature of the remains which have been referred by Mr. Salter to *Pterygotus* (but by the author to *Eurypterus*) *punctatus* was first discussed by the author, who came to the conclusion that the Lanarkshire specimens belong to a new species—*Eurypterus scorpioides*,—while the chelate antennæ and the detached lip-plate from Ludlow must have belonged to other species.

Eurypterus scorpioides is the first of the new forms now described by Mr. Woodward, and is represented by a specimen exhibiting an almost entire individual, and certain other fragments. The punctate ornamentation of this species may be readily distinguished from the scale-like markings of *Pterygotus* and *Slimonia*. The second new form, *Eurypterus obesus*, is remarkable for the great obesity of the thoracic somites; it is represented by the impression and counterpart of an entire specimen. Its small size suggested to the author the possibility of its being the young of some larger species. The third new species, *Pterygotus raniceps*, is at present known only by a single example; its head is remarkable on account of its obtusely pointed triangular form and prominent marginal eyes.

In conclusion the author made some observations on the structure of *Pterygotus*, showing that it possessed a series of branchial plates, —leaf-like bodies presenting a highly vascular and delicate structure, arranged in a linear series of from six to eight in each row, and appearing to have occupied a position beneath the thoracic plate on the ventral surface of the body, as seen in *Limulus* at the present day. He also suggested that *Pterygotus peronatus* and *P. crassus* are, possibly, both varieties of *P. bilobus*; they are all possessed of a bilobed telson or tail-plate.

2. "On the Coniston Group." By Professor R. Harkness, F.R.S., F.G.S., and Dr. H. A. Nicholson, F.G.S.

The object of this communication was to record the occurrence of a new and unique horizon, containing a rich Graptolite-fauna, in that portion of the Silurian series of the Lake-district termed the Coniston-flags by Professor Sedgwick. The authors also gave a detailed description of these flags, and pointed out their physical and palæontological relations with the Coniston Limestone below, and the Coniston Grits above them.

The palæontological relations of the Coniston Limestone and of the underlying green slates and porphyries have been previously shown to be those of the Bala and Caradoc group. The mudstones succeeding to the Coniston Limestone yield an entirely new fauna, including six species of *Diplograpsus*, all of which, with one exception, are in Britain characteristic Upper Llandeilo forms; and the evidence of the other species is in the same direction. In Ireland, however, many of these species have been obtained from strata of Caradoc age. The fossils of the Coniston Grits have very little affinity with those of the Kendal Flags, nor do they exhibit such a facies as would connect them with the lower members of the Upper Silurian series. Palæontologically, therefore, this Coniston series must be looked upon as a continuous group of rocks, and the physical evidence leads to the same conclusion. There is, thus, in the Lake-district, a greater development of Caradoc and Bala rocks than is to be found elsewhere in the British Islands, as we are now required to add a great thickness of strata, possessing, on the whole, a decidedly Lower Silurian fauna, but containing some new forms of life in its higher portions.

3. "Death of Fishes on the coast of the Bay of Fundy." By Dr. A. Leith Adams, F.G.S., 22nd Regiment.

On the 24th of September, during a heavy gale from the west, impinging almost straight on to the entrance of the Lagoon, known as Anderson's Cove, enormous numbers of fish were observed floating dead upon the surface of the water, and thrown up in quantities by the waves. On the gale subsiding, the whole surface of the lagoon and its banks were covered with dead fish, to the depth of a foot in some places. It was evident that the shoal had been literally ground to pieces against the rocks by the force of the waves. In conclusion the author referred to the vast quantities of fossil fish found in the

Devonian and other strata, which suggested catastrophes allied to the above incident.

4. "On Volcanoes in the New Hebrides and Banks Islands." By R. Atkins, Esq., of the Southern Cross." Communicated by J. Codrington, Esq., F.G.S.

The author described the islands of Tanna, Lopevi, and Ambrym, in the New Hebrides, and Santa Maria and Great Banks Islands, among the Banks Island group, as being now active volcanoes, and gave an account of a visit to the Hot Springs of Great Banks Island. These springs deposit quantities of almost pure sulphur.

EDINBURGH GEOLOGICAL SOCIETY, 2nd April, 1868.—In the absence of Mr. Powrie, one of the Vice-Presidents of the Society, Dr. Page read a paper prepared by that gentleman, "On the Working together of Volcanic and Denuding Agencies in the Formation of the Scenery of Scotland," which was in opposition to the theory propounded and advocated by Mr. A. Geikie, in his recent publication on the Scenery of Scotland, as also the theory recently advocated by the Duke of Argyll. It will be remembered that Mr. Geikie gives primary prominence to denudation, while the Duke of Argyll gives primary prominence to volcanic agencies alone, and catyclismal revolutions. Mr. Powrie exhibited a very elaborate section embracing the district from the Grampians over Strathmore, the Sidlaws to the Ochils, and particularly detailing the valley of the Tay. He clearly showed that a subsidence must have taken place in the valley of the Tay from the fact of two lines of faults, one on either side of the valley, with the upper Old Red Sandstone in the valley lying unconformably to the Old Red; whereas Mr. Geikie's theory maintains that a hill formerly occupied the present valley of the Tay, while Mr. Powrie advocates not only denuding agencies, but also a subsidence of the valley, and that it is to volcanic agencies the direction of the denuding currents are mainly due. Mr. Powrie, from his great local knowledge of the district of the Tay and the Forfarshire Old Red Sandstone, was enabled to give minute details of the various positions which thay occupy, as well as the numerous outbursts of trap injected through them. He further stated, in opposition to Mr. Geikie, that the valley of the Tay and the Carse of Gowrie must have been all occupied by the upper Old Red Sandstone to the top of the Ochils, or that the upper Old Red now occupying the valley of the Tay at a considerably lower level than where it crops out in the neighbouring districts, clearly shows a "downthrow" in the valley of the Tay. Mr. Powrie also exhibited upon his section the line of the hypothetical hill supposed to have been washed away or denuded from the valley of the Tay.—*Dundee Advertiser.*

GEOLOGICAL SOCIETY OF GLASGOW, MARCH 5TH, 1868.—"Miscellaneous Notes on Chemical Geology." By J. Wallace Young.

1st. On the Analysis of Foliated Chlorite from St. Catherine's Loch, Fyne. Colour, blackish green; lustre, pearly; consists of long narrow foliæ cohering together, rendering the mineral almost fibrous in appearance, in thin leaves, nearly transparent. When in a state of very fine subdivision it is entirely decomposed by sulphuric acid.

Sp. Gr. 2·781.

Silicic Acid	33·55
Alumina	15·00
Ferrous Oxide	10·78
Magnesia	29·73
Water (by difference)	10·94
	100·00

In one specimen the chlorite was associated with a ferriferous dolomite in rhomboidal crystals. Its composition was as follows:—

Sp. Gr. 2·935.

Carbonate of Lime	53·00
„ Iron	8·16
„ Magnesia	39·00
	100·16

Trace of Manganese.

2nd. On the presence of Sulphide of Zinc in a crystalline carbonate from a trap dyke at Fairly, Ayrshire, Mr. Wünsch drew the attention of the author to some small brownish-black crystals enclosed in a carbonate of iron, lime, and magnesia. On applying suitable tests they were found to consist of sulphide of zinc and some sulphide of iron. No carbonate of zinc was present. A portion of the trap rock from the dyke itself was tested carefully for zinc, but none was found.

3rd. On a deposit from a Chalybeate water. Described as consisting of hydrated ferric oxide, with a little clay and sand mechanically intermixed. No lime was present. The water itself contained carbonate of iron and sulphate of lime, but no carbonate of lime.

4th. On Laumonite.

5th. On some mineral cavities in trap rocks. The author exhibited and described many specimens, showing the deposition of quartz crystals on carbonate of lime; also fluor spar and sulphate of baryta, on quartz and carbonate of lime.

CORRESPONDENCE.

YACHTING ON THE COAST OF NORWAY.

Sir,—I am making preparations for a trip to Stavanger, Bergen, and Trondhjun, starting after the middle of June. It has struck me that, believing myself a fair observer, though a very ignorant geologist, I might be of use to any more learned gentleman who might wish any marks of coast elevation in modern times observed, and also (being somewhat of a chemist) to mineralogists, so far as the time and opportunity of so limited a trip will allow. I shall hope to visit the further end of the Fjords, more especially of the Sagne Fjord. And, having had great experience in Glacier travelling, I shall spend some time, probably, about Fjerland, and the Justedal's Brœen. I shall be happy to do anything in that way also. I enclose my card, and any gentleman who may have a distinct operation to propose will meet with my best attention to his communication. M. H.

London, *April* 11, 1868.

ORMEROD'S INDEX TO THE QUARTERLY JOURNAL AND TRANSACTIONS OF THE GEOLOGICAL SOCIETY.

Sir,—I have kept up my interleaved copy of my Geological Index down to the end of last year, 1867. Thinking that you might feel interested in a tabular view of the progress of Geology, which is shown by a comparison of the number of papers and authors included in the Index (occupying a space of 49 years) with those in the manuscript Supplement (occupying a space of 12 years), I send you a copy which I think is satisfactory as to the results. The great point is the increase in the number of authors: 288 *fresh names* having appeared in the Quarterly Journal during the last twelve years, and these may be considered of course as only the *créme* of the Geologists. If the inclosed statistics are of any use to your Magazine, they are at your service.

	Titles of Papers in Index. 1807 to 1855 (inclusive). 49 years.	Titles of Papers in Supplement. 1856 to 1867 (inclusive). 12 years.	Authors of Papers in Index. 1807 to 1855.	Authors of Papers in Supplement. 1856 to 1867.
Tertiary & Recent.	575	436	310	31 Old authors. 273 New ditto.
Secondary	693	434	330	45 Old. 229 New.
Palæozoic	658	397	273	47 Old. 184 New.
Metamorphic	190	112	104	13 Old. 54 New.
Volcanic	288	170	145	21 Old. 85 New.
Plutonic	180	110	101	12 Old. 63 New.
Topographical.. Geology .... Miscellaneous...	232	109	179	6 Old. 81 New.
Mining, etc.	216	144	144	13 Old. 83 New.
Palæontology... General	23	16	13	1 Old. 11 New.
Fauna	493	353	162	29 Old. 102 New.
Flora	80	50	39	8 Old. 25 New.

Districts and Localities described.

	Index.	Supplement.
British Islands	419	100 Old Localities. 164 New ditto.
Europe	255	61 Old. 161 New.
Asia	113	18 Old. 26 New.
Australia	36	9 Old. 16 New.
Africa	27	6 Old. 15 New.
America, North	59	10 Old. 12 New.
„ South	25	6 Old. 21 New.
„ Islands	8	2 Old. 4 New.

N.B. In this list a place is only entered once; but divisions, such as "North Devon" and "Devon," would be counted as separate localities.

Authors.

Number of authors in Index	536
Number of new authors in the Supplement	288
Number of old authors who have papers in the Supplement written on formations which they had not treated upon in Index	91

The number of authors writing on old subjects has not been calculated.

Chagford, Exeter. Geo. War$^{g.}$ Ormerod.

SUBMERGED FORESTS, AND RAISED SEA-BEACHES.

Sir,—In the Quarterly Journal of the Geological Society for February, page 4, Mr. Wynne says that peat and timber trees are found beneath the Youghal Strand. In accounting for this he goes into the old error of the necessity of a "subsidence of the land." Mr. Wynne says: "At some time (about the close of the Glacial period perhaps) . . . . . the land became depressed—it may be generally—as such evidences are common round the shores of Ireland as well as parts of England, but whether generally or locally, the land here sank to a depth of more than 90, perhaps 100 feet, or even more. Subsequently, to this depression of 90 or 100 feet the land rose again." Mr. Wynne further says that, "On the landward side of the beach the low ground is covered with peat . . . . . The water from the low boggy ground is conveyed through the beach by the usual contrivance of tidal floodgates or sluices, so that there is reason to believe that the peat on land and that beneath the bay are at the same level, and connected under the beach; and that the sea, by throwing the beach up, has banked itself out from a considerable portion of the low ground."

This is the precise description which I have given in Rain and Rivers of our English so-called "submerged forests." They are all *choked up estuaries,* and Mr. Wynne and every one else must see that as the sea erodes the whole line of coast, the beach will travel landward, and the peat and roots of trees which it covered will be uncovered and submerged by the sea. But there needs no "subsidence" for this. On the contrary, the raised beach which Mr. Wynne mentions, and those near the English "submerged forests," prove exactly the reverse. These raised beaches prove a rising of the land. As I have said (page 123), the so-called "submerged forests" are simply the results of the most gradual operations of rain, rivers, and the sea. In former days the stream or the rain valley cut its estuary far deeper even than low-water-mark, and formed what is called an arm of the sea. In later days the sea throws up a bank of shingle across the mouth of the deep-cut estuary, completely dams itself *out*, and partially dams the streams *in*, though these often soak through the shingle at low-water so as never to rise near the height of high water. Thousands of such cases exist in England. These sea beaches thrown up by storms frequently stand not only very much higher than the high water of the sea which throws them up, but the land behind them is often much lower than the high water of the sea. And thus, according to circumstances, peat, pasture, or wood, grows *below the high-water mark*. The rapidity of the growth of alluvial deposit from periodical inland floods is then much increased. For all the alluvial wash of the entire valley or water slope is here at once stopped short, none of it can percolate the shingle into the sea. Deposit is rapidly accumulated on deposit, and rooted trees are found under peat, in peat, and above peat, not only on the shore outside the shingle bank, but in cutting the sluices inside the shingle bank, and by degrees the land which was below water-mark may be raised by alluvial deposit far above high-water mark. When man appears on the scene, if fine alluvium plasters up the shingle enough to hold back the water, it is a common practice to dig a trench a few feet into the clean shingle. The water may then be seen to flow into the shingle in a stream. Or, if circumstances admit, a trench is cut completely across the shingle bank, and occasionally cleaned. Then come sluices and iron piping beneath the shingle bank. The land drainage is *let* out at low water, and the sea *kept* out at high water. Millions of acres of our best pasturage far below high-water-mark are held on this tenure. But when the streams are embanked, and are let off to the sea so perfectly as to prevent their natural annual overflow, annual denudation of the old alluvium will take place instead of deposit of new alluvium, and the land may again become denuded far below the usual tidal level." The chalk flints mentioned by Mr. Wynne are quite en regle. That is (speaking literally) all erratics, including what is absurdly called "Northern drift," have travelled on sea-shores. (See chapter on travelling of sea beach in Rain and Rivers.)

At page 2 of the same geological journal, Mr. Tylor, while he considerately spares us "a gravel period," creates a bran new period of his own—a pluvial period. With this implement (notwithstanding that "the valley of the Somme had assumed its present form prior to the deposition of any of the gravel or 'loess' now to be seen there"), he floods the valley "eighty feet above the present level of the Somme." These prodigious bodies of water do not in the least erode the soft chalk sides, or the bed of the valley, but, on the contrary, they deposit the gravel terraces as their high-water mark. Flints, therefore, in the pluvial period must have been lighter than water, and must have floated on the surface to their present position. In periods other than the pluvial one drift is driven along the beds of rivers and valleys. And these terraces of the Somme have been the beds of the river or valley, as I have had the honour to state in the GEOLOGICAL MAGAZINE for May, 1867.

BROOKWOOD PARK, ALRESFORD. GEORGE GREENWOOD, Colonel.

CYCLOPHYLLUM FUNGITES.

SIR,—In the last number of the GEOLOGICAL MAGAZINE, Dr. Duncan made some remarks upon a statement of mine which appeared in your Magazine for March, 1868. I beg now to offer a few words of explanation.

Dr. Duncan writes, "Mr. Young also appears to have stated that David Ure was the original discoverer of the genus in question, and that Prof. M'Coy had clearly delineated the various parts constituting the internal organization of this coral; to these statements I must give my unqualified contradiction."

In my remarks I only wished to imply that David Ure was the original discoverer of the species of coral upon which Dr. Duncan's new genus was founded, *not* the discoverer or author of the various generic and specific names that have since been applied to it.

As to whether Prof. M'Coy has or has not delineated in his figures and description all the essential points in the internal organization of this coral, or whether Dr. Duncan is warranted in establishing new generic characters upon the points which he says he was the first to discover, this I will leave to the decision of those palæontologists who are better able than I am to decide in this matter. The parts of this coral upon which Dr. Duncan founds his generic distinctions, were not, I think, so entirely unknown to Prof. M'Coy, as Dr. Duncan's remarks would imply. With him, however, they did not constitute points of generic distinction, but only served, as he states, to characterise a well-marked species.

I was induced to make those remarks to which Dr. Duncan has seen fit to reply, from being present at a meeting of the Geological Society of Glasgow, on the 18th of April, 1867, when Mr. James Thomson exhibited a coral, which he asserted to be new to science (I will not say that he did this with Dr. Duncan's consent). I had not then seen Messrs. Duncan and Thomson's joint-paper on *Cyclophyllum fungites*, but I stated in my remarks that I believed it was founded upon the species of coral first discovered by David Ure, and figured by him in his book as a *Fungites* in the year 1793, but which had subsequently received new generic and specific names from Fleming, M'Coy, and Milne-Edwards.

Since then Mr. Thomson has obtained the loan of Ure's original specimen from the collection of the Royal Society of Edinburgh, has had it cut and polished; and has thus proved that *Cyclophyllum fungites* of Duncan and Thomson is Ure's *Fungites*; the point for which I have all along contended. JOHN YOUNG.

HUNTERIAN MUSEUM, COLLEGE, GLASGOW,
April 8th, 1868.

FISH-REMAINS IN THE LOWER DEVONIAN OF SOUTH DEVON AND CORNWALL.

SIR,—Mr. Salter, in going over my late son's collection, has made a somewhat important discovery, which he has requested me to communicate to you.

There has been so much doubt thrown upon the specimens identified with fish remains in Devonian rocks, whilst they are known to swarm in the Old Red sandstone, that every communication on the subject is of some importance.

It will be remembered that many supposed remains of fish from the slate rocks of Polperro, in Cornwall, were identified by Professor M'Coy with the Sponges. On this new form of sponge he bestowed the name *Steganodictyum*, describing it as a reticular layer overlaid by a striated coat. Some specimens of this are in my late son's collection. But with them is a large and well preserved plate, six inches long, which evidently belongs to a species of *Pteraspis.*

Of course, only the usual nuchal plate is preserved; but the markings on this are so perfect as to render it almost impossible to mistake the nature of the fossil. The closely-set sinuous grooves, occasionally interrupted, and disposed in concentric fashion over the whole plate, are rather closer together than in the ordinary species of *Pteraspis* from the Cornstone rocks. The species is undoubtedly new to Britain, although Mr. Salter has not, at present, the means of comparing it with the one described by Roemer from the Lower Devonian of Germany.

The point of interest is, of course, the finding a Lower Old Red Sandstone fish in Lower Devonian rocks in our own country. It also throws doubts upon the relationship of *Steganodictyum* to the sponges, inasmuch as this fossil shows cells like those of that genus immediately beneath the striated coat, whilst specimens of *Steganodictyum*, also in this collection, show the internal layer of the fish-plate with the cellular layer above it.

I only wish to draw attention to this fact. Mr. Salter will probably send you a fuller description than is contained in these few notes; but he thinks that no time should be lost in making the fact known. E. WYATT-EDGELL.

2, LANSDOWNE PLACE, LADBROKE SQUARE, W.,
11th April, 1868.

Having—together with Mr. E. Ray Lankester—examined the late Mr. Wyatt-Edgell's specimens of the so-called *Steganodictyum Cornubicum* and also the cephalic plate of *Pteraspis*, from Mudstone Bay, South Devon, and compared them with Roemer's type-specimen of

Pteraspis (*Archæoteuthis*) *Dunensis* from the Lower Devonian of the Eifel (preserved in the British Museum), and with M'Coy's figures of the Cornish specimen[1]—we fully concur in Mr. Salter's identification of M'Coy's genus *Steganodictyum* with the *Pteraspidian* plate in Mr. Wyatt-Edgell's collection, and consider that they must both be referred to the genus *Scaphaspis* (see Brit. As. Rept. 1864, and Geol. Mag., 1864, Vol. I. p. 292); and, further, that the Cornish specimens cannot at present be separated specifically from Roemer's *Pteraspis* (*Archæoteuthis*) *Dunensis*. As M'Coy's specific name, *Cornubicum*, however, bears date 1851 (Ann. and Mag. Nat. Hist., 2nd ser., vol. viii.), and Roemer's name, *Dunensis*, was given in 1855 (Palæontographica, Dunker and von Meyer, vol. iv. p. 72, tab. xiii.), the name to be adopted should be *Scaphaspis Cornubicus*. The late Dr. S. P. Woodward called attention to the ichthyic character of Roemer's supposed *Archæoteuthis* in his Manual of Mollusca, 1856, p. 417.

Henry Woodward.

P.S. Since the above was written, Professor Huxley informs me that Mr. Leonard Lyell brought to him for examination (some six weeks ago) specimens of the so-called *Steganodictyum* of McCoy, from South Devon and Cornwall, from the cabinet of W. Pengelly, Esq., F.R.S., of Torquay, which he at once pronounced to be true cephalic plates of *Pteraspis*. H. W.

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[1] See Sedgwick and M'Coy's Palæozoic Fossils (Tab. 2A. fig. 1, 3). It is highly probable that *Steganodictyum Carteri*, M'Coy, from the Devonian of Cornwall (Tab. 2A. fig. 4), is founded on a fragment of a cephalic plate of *Cephalaspis*.

Aërolitic Shower.—Poggendorff's Annalen (Band cxxxiii.) contains a notice of a recent great fall of Meteoric Stones, of which the following is a summary:—On the 30th of January of the present year, a number of Stone Aërolites fell at Sielce and Gostkow, near Pultusk, in Poland. Many details of the fall are yet wanting; but, according to the accounts which have already reached us, the phenomena accompanying it appear to have been of the usual kind. A large fire-ball was seen about seven o'clock in the evening, passing rapidly from the North-West to the South-East, with a constantly increasing brilliancy, and at last exploded with a great noise, scattering a shower of stones in the immediate vicinity of the above places. This fire-ball was visible in Silesia, Prussia, Posen, etc. Professor Eberhard Fugger, of Stockerau, Austria, under the date of February 7th, gives the following account of the meteor as seen at that place. It may be premised that the distance between Stockerau and Pultusk is nearly 400 miles as the crow flies. "On the 30th of January of this year, a brilliant meteor was observed here. About ten minutes before seven in the evening, a blue flaming ball showed itself, which appeared to come from the moon; it travelled towards the South-East, becoming during its progress larger and more brilliant, a blue light at the same time spreading itself over the neighbourhood. The ball gradually disappeared behind the mountains on the right bank of the Danube, decreasing in size, and, after it had completely disappeared, a sudden crack like thunder was heard. When the meteor was at its greatest size, it did not appear to be higher from the ground than double the height of a church-tower. This phenomenon lasted for fifteen seconds, and was visible at Brünn and other places. A similar meteor was observed in Stockerau on the 21st of January of this year, at 7.40 p.m." A stone as large as a child's head is reported to have fallen at Baden-Baden, at eleven o'clock on the same evening as those near Pultusk, some fragments of which are said to have been received by the Dantzic astronomer, Kayser. Several of the Sielce and Gostkow stones, ranging from a few ounces to 7lbs. in weight, have been forwarded to the British Museum. The interior of these stones is of a bluish-grey colour, somewhat similar to those which fell at L'Aigle, in France, in April, 1803; and the crust is of a dull black and brown colour, and of varying thickness. T. D.

THE
GEOLOGICAL MAGAZINE.

No. XLVIII.—JUNE, 1868.

ORIGINAL ARTICLES.

I.—On Denudation now in Progress.[1]

By Archibald Geikie, F.R.S., Director of the Geological Survey of Scotland.

THE extent to which a country suffers denudation at the present time is to be measured by the amount of mineral matter removed from its surface and carried into the sea. An attentive examination of this subject is calculated to throw some light on the vexed question of the origin of valleys and also on the value of geological time. Of the mineral substances received by the sea from the land, one portion, and by far the larger, is brought down by streams, the other is washed off by the waves of the sea itself.

I. The material removed by streams is two-fold; one part being chemically dissolved in the water, the other mechanically suspended or pushed along by the onward motion of the streams. The former, though in large measure derived from underground sources, is likewise partly obtained from the surface. In some rivers the substances held in solution amount to a considerable proportion. The Thames, for example, carries to the sea every year about 450,000 tons of salts invisibly dissolved in its waters. But the material in mechanical suspension is of chief value in the present enquiry. The amount of such material annually transported to the sea by some of the larger rivers of the globe has been the subject of careful measurement and calculation. Much has been written of the vastness of the yearly tribute of silt borne to the ocean by such streams as the Ganges and Mississippi. But, as was first pointed out by Mr. Tylor, "the mere consideration of the number of cubic feet of detritus annually removed from any tract of land by its rivers does not produce so striking an impression upon the mind as the statement of how much the mean surface level of the district in question would be reduced by such a removal."[2] When the annual discharge of sediment and the area of the river-basin are both known, the one sum divided by the other gives the fraction by which the area drained by the river has its general level reduced in one year. For it is clear that if a river carries so many millions of cubic feet of sediment every year into the sea, the area of country drained by it must have lost that quantity of solid material, and if we could restore the sediment so as to spread it over the basin, the layer so laid down would represent the fraction of a foot by which the basin had been lowered during a year.

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[1] Abstract of part of a paper read before the Geological Society of Glasgow on 26th March, and which will appear in a forthcoming part of the Transactions of that Society.

[2] Tylor, Phil. Mag., 4th series, v. 260 (1853). My attention was first called to this very obvious and instructive method of representing the results of denudation by some remarks of Mr. Croll in the Phil. Mag. for February, 1867. Mr. Tylor's earlier publication was afterwards pointed out to me by Professor Ramsay. Mr. Croll, following up the line of argument suggested in his former paper, has gone into further detail upon this subject in a memoir published in the Phil. Mag. for this month (May), which will be of essential service to geology.

Thus the Ganges has its drainage area lowered by $\frac{1}{2358}$ of a foot per annum.[1]
Mississippi „ „ $\frac{1}{6000}$ „ „
Hoang Ho „ „ $\frac{1}{1464}$ „ „
Rhone „ „ $\frac{1}{1528}$ „ „
Danube „ „ $\frac{1}{6846}$ „ „
Po „ „ $\frac{1}{729}$ „ „

The laborious investigations of Messrs. Humphreys and Abbot[2] have shewn that in the water of the Mississippi the amount of sediment is $\frac{1}{1500}$ by weight. This is a much smaller quantity than that in many other rivers of the globe. Taking it, however, as an approximate mean for the rivers of this country, we find that

The Thames lowers its drainage basin by $\frac{1}{11740}$ of a foot per annum.[1]
Tay „ „ $\frac{1}{1842}$ „ „
Forth „ „ $\frac{1}{3111}$ „ „
Boyne „ „ $\frac{1}{6700}$ „ „

It is much to be desired that careful measurements should be made of the quantity of silt carried down by our British rivers. In the case of the Nith a series of measurements and deductions made by the engineer on the river led him to the conclusion that the quantity of detritus borne by that stream into the Solway Firth reaches every year an amount varying from 112,000 to 120,000 cubic yards.[3] This is equal to the lowering of the surface of the basin of drainage by about $\frac{1}{4500}$ of a foot per annum.

But besides the materials held in suspension there must also be taken into account the quantity of sand and gravel pushed along the bottom. In the case of the Mississippi this was estimated by the United States Survey at 750,000,000 cubic feet. In our own rivers it is probably on the whole proportionally greater. Indeed the amount of coarse detritus carried down even by small streams is almost incredible. Mr. Thomas Stevenson, the eminent harbour engineer, informs me that at Lybster on the Caithness Coast, where a harbour has been constructed at the mouth of a small stream, between 400 and 500 cubic yards of gravel and sand are every year carried down by the stream. The area of drainage is estimated at about 4 square miles. A weir or dam has been constructed to protect the harbour from the inroad of the coarser sediment, and this is cleaned out regularly every summer. A great deal of fine silt must be swept out to sea, yet the portion of detritus caught by the weir, and annually moved, represents a yearly lowering of the surface of this little sin by $\frac{1}{12000}$ of a foot.

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[1] These fractions represent the amount of solid rock removed from the drainage-basins, allowing 1·9 as the specific gravity of the silt, and 2·5 as that of average rock.

[2] Report on the Physics and Hydraulics of the Mississippi River. 1861.

[3] Appendix C to Second Report of Tidal Harbour Commission, 1847, p. 603.

Comparing the measurements which have been made of the pro- rtion of sediment in different streams we shall probably not assume o high an average if we take that of the carefully elaborated Survey the Mississippi. This gives an annual loss over the area of drain- e equal to $\frac{1}{6000}$ of a foot. If then a country is lowered by $\frac{1}{6000}$ of a ot in one year, should the existing causes continue to operate undis- rbed as now, it will be lowered 1 foot in 6000 years, 10 feet in 60,000 ars, 100 feet in 600,000 years, and 1000 feet in 6,000,000 years. he mean height of the Continents, according to Humboldt's calcula- on,[1] is in Europe 671, North America 748, South America 1151, and sia 1132 English feet. Under such a rate of denudation therefore urope must disappear in little more than four million of years, orth America in about four millions and a half, South America and sia in less then seven millions. These results do not pretend to be ore than approximative, but they are of value inasmuch as they nd to shew that geological phenomena, even those of denudation, hich are often appealed to as attesting the enormous duration of eological periods, may have been accomplished in much shorter in- rvals than have been claimed for them. The demands made by eologists for unlimited ages during which the history of the earth as been advancing are opposed by modern physics. It will as- redly be necessary to revise the whole subject of geological time, nd in the end to accept a much lower antiquity for our planet than as been on geological grounds assigned to it.

The material carried to sea by rivers has been spoken of in the revious part of this paper as having been removed from the general rea of drainage, which in consequence is thereby reduced in level. t is of importance to look at the subject from this point of view in rder to obtain some adequate idea of the extent of the loss which he land is constantly undergoing before our eyes. But it is obvious hat the material so removed does not come equally from the whole rea of drainage. Very little may be obtained from the plains and atersheds; a great deal from the declivities and valleys. It may ot be easy to apportion its share of the loss to each part of a istrict, but the sum total of denudation is not affected thereby. f we allow too little for the loss of the table-lands, we increase the roportion of the loss sustained by the slopes and valleys, and *vice ersa.* There can be no doubt that the erosion of the slopes and ater-courses is very much greater than that of the more level rounds. Let it be assumed that the waste is nine times greater in he one case than the other (in all likelihood it is more); in other ords, that while the plains and table-lands have been having one oot worn off their surface, the declivities and river-courses have ost nine feet. Let it be further assumed that one-tenth part of the urface of a country is occupied by its water-courses and glens, while he remaining nine-tenths are covered by the plains, wide valleys, r flat grounds. Now, according to the foregoing data, the mean annual quantity of detritus carried to the sea is equal to the yearly loss of $\frac{1}{6000}$ of a foot from the general surface of the country. The valleys, therefore, are lowered by $\frac{1}{1200}$ of a foot, and the more open and flat land by $\frac{1}{10800}$ of a foot. At this rate it will take 10,800 years before the level ground has had a foot pared off its surface, while in 1200 years the valleys will have sunk a foot deeper into the framework of the land. By the continuance of this state of things a valley 1000 feet deep may be excavated in 1,200,000 years. We may take other proportions, but the facts remain, that the country loses a certain ascertainable fraction of a foot from its general surface per annum, and that the loss from the valleys and water-courses is much larger than that fraction, while the loss from the level grounds is much less.

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[1] Asie Centrale, tome i. 168.

It seems an inevitable conclusion that those geologists who point to deep valleys, gorges, lakes, and ravines, as parts of the primeval architecture of a country, referable to the upheavals of early geological time, ignore the influence of one whole department of natural forces. For it is evident that if denudation in past time has gone on with anything like the rapidity with which it marches now, the original irregularities of surface produced by such ancient subterranean movements must long ago have been utterly effaced. That the influence of these underground disturbances has often controlled the direction in which the denuding forces have worked, or are now working, is obvious enough; but it is equally clear that under the régime of rain, frost, ice, and rivers, there must have been valley-systems wherever a mass of land rose out of the sea, irrespective altogether of faults and earthquakes. No one who has ever studied rocks in the field is likely to overlook the existence of faults and other traces of underground movement. But he meets everywhere with proofs of the removal of vast masses of rock from the surface, which no amount of such movements will explain. At their present rate of excavation the "gentle rain from heaven," and its concomitant powers of waste, will carve out deep and wide valleys in periods which, by most geologists, will be counted short indeed. And if an agency now in operation can do this, it seems as unnecessary as it is unphilosophical to resort to conjectural cataclysms and dislocations for which there is no evidence, save the very phenomena which they are invented to explain.

In reference to the origin of the present configuration of the earth's surface, attention has recently been more specially drawn to the Highlands of Scotland as retaining in great measure the "aboriginal outline" impressed upon them by ancient upheavals and fractures. To this subject it may be proper to return on another occasion. In the meantime it may be remarked that these subterranean movements must have happened previous to the formation of the Old Red Sandstone. If, then, the present outlines of the surface are, in the main, older than that formation, it is evident either that the time of the Old Red Sandstone cannot be removed by any long period from our own day, otherwise these outlines would have been obliterated by atmospheric waste, acting even no faster than it is doing now;

r that the rate of denudation (and consequently of deposition) must
ave been in past time infinitely slower than at the present day.
he former half of the alternative will be at once rejected; the latter
oes in the face of all received geological belief.

In accordance with the views now expressed, existing lakes as a
le must be of comparatively modern origin. We see that the
reams which enter them push yearly increasing deltas into the
ater. The rate at which the deltas grow shows that they cannot,
a geological sense, be very old. If the delta of the Rhone has
ept a mile and a half into the lake of Geneva during eight cen-
ries, a thousand years must represent no insignificant fraction of
e interval since the river began to push its detritus into the lake.
ad the lake basin, therefore, been of ancient origin, it must neces-
rily have been long ago filled up with sediment; and, once in that
ndition, no power of running water could re-excavate it so as to
rn it into a lake again. If the immense mass of lakes scattered
er the temperate and northern parts of our hemisphere be due in
y large measure to underground forces, there must have been in
cent geological times an amount of dislocation, upheaval, and de-
ession, of which there is no other evidence, and which indeed is
rectly contradicted by the actual facts. We are driven, therefore,
seek some explanation which will account for these rock basins
the admission that they are of recent date, and cannot be due to
derground agency. The theory of Professor Ramsay—that they
ere scooped out by the ice of the Glacial period—harmonizes these
stulates, and furnishes a most important element in the elucidation
the history of the earth's surface.

II.—The detritus wasted from the land is carried away not only
streams, but in part also by the waves and currents of the sea.
et if we consider the abrasion due directly to marine action, we shall
led to perceive that its extent is comparatively small. In what
called *marine denudation*, the part played by the sea is rather that
removing what has been loosened and decomposed by atmospheric
gents than that of eroding the land by its own proper action.
ndeed, when a broad view of the whole subject is taken, the amount
denudation which can be traced to the direct effects of the sea
lone is seen to be altogether insignificant. Yet even if we grant
the action of the waves and tides all that is usually included
nder marine denudation, the sum total of waste along the sea-
argin of the land is still trifling compared with that effected by
e meteoric agents upon the interior. Islanders, as we are, familiar
rom infancy with the fury of the breakers which beat along our
oast-line and strew it with wrecks, we are apt to attribute to the
cean too great a share in the work of wearing down the land.
ven in an island like Britain the extent of surface exposed to the
ower of the waves is very small indeed when contrasted with that
hich is under the influence of atmospheric waste. And, of course,
the case of the continents the discrepancy is infinitely greater.
n the general degradation of the land this is an advantage in favour
the subaërial agents, which would not be counterbalanced, unless

the rate of waste by the sea were many thousands or millions of times greater than that of rains, frosts, and streams. But no such compensation exists. Let us suppose that the sea eats away a continent at the rate of ten feet in a century—an estimate which probably attributes to the waves a very much higher rate of erosion than can as the average be claimed for them,—then a slice of about a mile in breadth will require about 52,800 years for its demolition, ten miles will be eaten away in 528,000 years, one hundred miles in 5,280,000 years. But we have already seen that on a moderate computation such a continent as Europe will, at the present rate of subaërial waste, be worn away in about 4,000,000 years. Hence, before the sea could pare off more than a mere marginal strip of land between 70 and 80 miles in breadth, the whole land would be washed into the ocean by atmospheric denudation.[1]

If therefore the elements have acted upon the surface of the land in past time with any approach to the proportions in which they are acting now, it is clear that the sea can have played but a secondary part in modelling the outlines of a continent. It may be objected, to this conclusion, that the traces of wide level tracts, known as plains of marine denudation, so commonly to be met with over the earth's surface, can only be attributed to sea-action, and prove the sea to have had no small share in the general task of planing down the land. These plains are, indeed, in all probability, referable to the action of the sea; but if we reflect on the tendency of atmospheric waste, we must perceive that such plains are the natural and necessary result of that waste. In short, a "plain of marine denudation" is the sea-level, to which a mass of land has been reduced by rains, ice, and streams,—the line below which further degradation became impossible, because the land was thereafter protected by being covered by the sea. Undoubtedly the last touches in the long process of sculpturing were given by the waves and currents; yet in the past history of our planet the influence of the ocean has been far more conservative than destructive. Beneath the reach of the waves the surface of the submerged land has escaped the demolition which sooner or later overtakes all that rises above them, and there too have been accumulating the sedimentary materials out of which the existing continents have been framed.

II.—The Suffolk Bone-bed and the Diestien or Black Crag in England.

By E. Ray Lankester, Junior Student of Christ Church, Oxford.

In the following pages, I am anxious briefly to make known certain new facts bearing on the history of the Crags which I have recently ascertained, and also to make some observations on papers lately published relating to those beds.

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[1] The action of meteoric agents and of the sea is independent of subterranean movements, and must go on whether a land is upheaved or depressed. These movements will in some cases favour subaërial denudation, in others marine denudation, as shewn in the paper of which the above is an abstract. But in taking a generalized view of the subject their influence may be disregarded.

In the November number of this journal, my friend, Dr. A. von Koenen, of Marburg, does me the honour of criticizing the paper which I published herein during 1865. As to matters of fact, Dr. von Koenen and myself agree most closely, but he has taken exception to my use of the terms Pliocene and Miocene. I now regret very much that I have ever used those terms at all; and agree with Mr. Godwin-Austen that they may tend to misunderstanding and confusion. It is, however, I must submit, rather strange that a geologist who adopts such an innovation as "Oligocene" should be severe on another as to the limitations of "Pliocene" and "Miocene." I hereby desire to abandon these terms altogether in speaking of the English and Belgian Crags, and by so doing I believe that I leave myself in complete accord with Dr. von Koenen as to the age of the Black Crag of Antwerp. It is a deposit which may be classed very naturally with the other Crags, but differs little from beds called Upper Miocene, agreeing with such especially in its Cetacean and Shark fauna. Dr. von Koenen also appears to have no high opinion of M. Nyst's conchological investigations, of which I availed myself in estimating the age of the Diestien and Scaldisien beds. In reply to this I must refer to my paper (Geol. Mag., 1865, p. 149), in which I gave the results of very careful analyses of the researches of Mr. Searles Wood and M. Nyst, corrected by the aid of my much-regretted friend Dr. S. P. Woodward. The per centage results which I arrived at—so far as they have any value (and I think they have considerable value)—are almost identical with those given by Mr. Prestwich, through Mr. Gwyn Jeffreys, in a paper recently read at the Geological Society.

The paper by Mr. Prestwich just referred to, has the great value which all the work of so eminent an observer carries. Hence I feel some gratification in pointing out that he recognises the existence of the so-called Coprolite bed at the base of both Coralline and Red Crag, containing both terrestrial and marine mammalian remains and Plagiostomous fish-teeth. This fact I first announced in my paper already referred to. Mr. Prestwich also confirms me in my observation of the different mineral condition of the "Coprolite bed" bones from that of those proper to the Crags. This fact I dwelt on at some length in a paper in the Quart. Journ. Geol. Society, 1865, p. 223. Further, Mr. Prestwich agrees to my deductions from these facts, and a study of the palæontological evidence, and he endorses my conclusion that the Cetacean and Shark remains of the Coprolite-bed are derived from a previous deposit of the age of the Système Diestien of Belgium.[1]

The existence in the Coprolite beds of a glauconitic sandy matrix adherent to many of the Cetacean remains, and of sandstone nodules containing fossils of Diestien age is not noticed by Mr. Prestwich. I have emphatically alluded to this sandy matrix in both the papers on the Crags, which I have published. I have now to state that during a recent visit to Suffolk I have obtained some thirty species of Mollusca (perhaps more) from these sandstone blocks, and that they are, as far as I have yet had leisure to examine them, of Diestien age. I have *Pectunculi*, an unusually large number of *Isocardiæ*, some of the form *I. lunulata*, *Voluta Lamberti* of the Diestien variety, differing notably from the Scaldisien, Red, and Coralline Crag form in its more elongate spire, *Pyrula* sp., and many others. The *Pyrula* figured by Mr. Searles Wood from one of these nodules differs from all the normal Red and Coralline Crag specimens so widely, that he gives it a distinct specific title. Mr. Wood appears to have had but few specimens from these nodules, and considered them of Coralline Crag age. The specimens are in the condition of casts, the shell being in almost every case dissolved away. They present a remarkable similarity in appearance to the fossils from the ferruginous sandstones of Lenham in Kent, which are reputed of Crag age. I had the pleasure of examining Mr. Prestwich's collection of these fossils with Dr. von Koenen some years since, and I think it very probable that their age, and that of the Suffolk sandstone nodules, is identical. That the latter are of Diestien age there can, I think, be little doubt; for in addition to the Mollusca we have the important evidence of the existence of the Cetacean remains in these rolled sandstones, and I have just obtained the largest *Carcharodon* tooth I have yet seen embedded in part in one of these sandstone nodules.

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[1] In former papers I have spoken of the bed from which the Cetaceans originally come as of Middle Crag age. This is an error; the Middle Crag of Antwerp is probably, as Mr. Godwin-Austen says, of Scaldisien age, with *remanié* Diestien forms in it. There is no doubt that the Antwerp Cetaceans and Sharks belong truly to the Diestien system, and hence it is to the derived Diesten fauna in the Middle Crag that our Coprolite fossils are related.

With regard to the so-called Coprolite-bed, which is evidently a great beach or littoral accumulation (like all other bone-beds) which was formed, immediately before the Coralline Crag, from the detritus of the London Clay, the Diestien or Black Crag, and the fragments of subaërial and fresh-water accumulations (whence its *Mastodon*, *Rhinoceros*, *Tapir*, *Hyæna*, *Sus*, and *Cervus* teeth), I wish to point out the impropriety of the term "Coprolite-bed" (which is the local name, and which, I believe, Mr. Prestwich adopts), for there is probably not one coprolite in the whole of it. The phosphatic nodules are masses of London Clay, often with characteristic fossils, such as may now be seen rolled about on Suffolk beaches; and these—by a process of substitution, which is no vague theory but a recognised chemical fact—have received some 50 per cent. of phosphate of lime from the vast quantities of fossil bones with which they were associated on the sea-shore. This same history applies to other phosphatic deposits, Cambridge, Potton, etc., as I believe Mr. Walker has pointed out. This being the case I propose to substitute the term "Suffolk Bone-bed" for "Coprolite-bed," since it does not involve an erroneous theory, and the bed in question is truly a "bone-bed," and comparable to other great "bone-beds," such as that at the base of the Lias.

I am able to offer an additional proof of the distinct character of the Suffolk Bone-bed, in its occurrence in a pit at Trimley on the Orwell, without any superimposed Crag, Red or Coralline. The section in this pit gave soil 1½ ft., clay with flints 4½ ft., red sand (from which I obtained a tooth of *Elephas meridionalis*) 12 feet, Bone-bed 1½ feet, consisting of phosphatic-clay nodules, sandstone nodules and slabs, bones, teeth, etc., with greyish white sand.

The study of chemical geology does not receive in this country the attention which it merits. The discussions in this Magazine on the chemistry of the Primæval earth, show who are the men to deal with such questions, but nothing appears to be done as to the *processes of fossilization*, a most important subject, which, if reduced to principles, would greatly aid students of Cainozoic geology.[1] The mineral conditions of the vertebrate remains of the Suffolk Bone-bed is a case in point. The enamel crowns only (with rare exceptions) of the teeth of terrestrial mammalia are found in it. Some persons have been astonished at the very great rarity of bones corresponding to the teeth of the terrestrial mammals, whilst bones in the same mineral condition as the cetacean teeth and tusks of *Trichecodon* are by no means so rare. I believe the explanation of this is to be found in the fact that the bones of land animals came on to the Bone-bed beach either in a fresh condition or in a very different state of preservation from the Diestien Cetaceans. The sea very rapidly destroys fresh bones by a chemical as well as mechanical action: this fact was elicited last year at Dundee, in the discussion on Mr. Gwyn Jeffrey's dredging report, who recorded the occurrence of a ferret's bone dredged from a considerable depth: this was the only bone of a land animal which Mr. Jeffreys had ever dredged, great as his experience has been. Thus it is that the cement and dentine of the teeth as well as the bones of the terrestrial mammals of the Crag Bone-bed have been destroyed, whilst the durable stony enamel crowns remain intact. It is very probable that many of the remains of terrestrial mammals in the Crag Bone-bed were embedded in fresh-water deposits contemporaneous with Diestien beds, which I have alluded to in other papers, as deposits of late Miocene or early Pliocene age. A most remarkable thing is the supposed persistence of *Mastodon Arvernensis* from this early period to the epoch of the Forest-bed of Norfolk; is it not a derived fossil there? The present coast-line of Essex, Suffolk, and Norfolk indicates and limits an area of alternate depression and elevation which commenced as early as the London Clay period (for here we find splendid teeth of *Coryphodon*, etc.), and is even now continuing. On the clay lands of the early Eocene flourished the small mammalia, whose remains are embedded in the Kyson sands, much later the *Mastodon*, *Tapir*, *Rhinoceros*, *Hyæna antiqua*, and others appeared on the scene.[2] These were succeeded by *Elephas* and *Hippopotamus*, and by other Rhinoceroses, with which perhaps the Mastodon still lingered on; whilst these again in turn gave way to yet other species of Elephant and large mammalia, and to these succeeded the historic fauna. These changes in the terrestrial fauna are thus briefly alluded to, in order to draw the line between them and the changes of the marine fauna as indicated by the mollusca, etc. It is a fundamental law of distribution that contiguous marine and terrestrial faunæ are rarely similarly affected by the same cause. Hence, whilst the sea may have undergone such changes as to convert its fauna from one of "Miocene" facies to one of sub-arctic facies, the same great mammals—all or only some—may have continued to hold the land.

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[1] No Elephant occurs with the Mastodon in the Suffolk Bone-bed. The late Dr. Falconer was, I believe, misled on this point, by specimens from the Red Sands above the Red Crag.

[2] Dr. Hugo Müller, whose name is well known among chemists, and who has paid especial attention to this subject, has kindly promised to communicate an article to the GEOLOGICAL MAGAZINE upon this very question, at a future day.—EDIT.

In conclusion, I have to record a new Cetacean from the Suffolk Bone-bed, indicated by a flattened foliaceous tooth with a dentate margin, probably belonging to the genus *Squalodon*. I have also further evidence of *Hyæna antiqua*.

III.—CONTRIBUTIONS TO BRITISH FOSSIL CRUSTACEA.

By HENRY WOODWARD, F.G.S., F.Z.S.

[PLATE XIV.]

I. *PYRGOMA CRETACEA*, H. Woodw.—In my first Report on Fossil Crustacea (Brit. Assoc. for the Advancement of Science, 1865, Reports, p. 321), I called attention to the occurrence, in the Upper Chalk of Norwich, of a sessile Cirripede belonging to the genus *Pyrgoma*. This unique example—for which I proposed the name of *Pyrgoma cretacea*—was discovered by Mr. T. G. Bayfield, of Norwich, who forwarded the specimen to the British Museum where I had the good fortune to detect its character. As no other specimen of this new species has been met with, I have thought it advisable (although only an imperfect example) to place it on record in the hope that better ones may be found. It is represented in the accompanying Plate XIV., Figs. 1 and 2, of the natural size.

The genus *Pyrgoma* was proposed by Leach (Journ. de Physique, tome 85, 1817) for a minute form of *Balanus* obtained living, on the south coast of England and Ireland, Sicily, Madeira, St. Jago, and the Cape de Verde Islands; generally found attached to the edge of the cup of a coral belonging to the genus *Caryophyllia*. The shell is formed of a single piece; the basis, cup-formed or sub-cylindrical; the scutal and tergal valves are articulated together.[1]

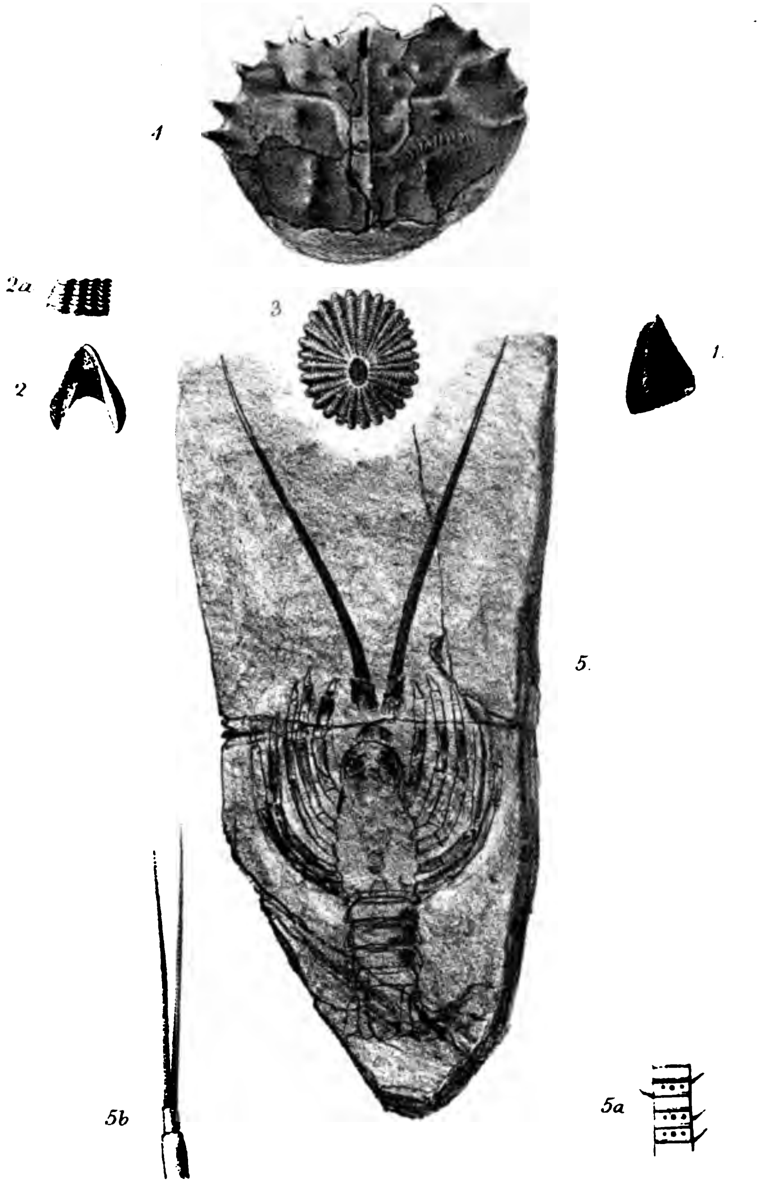
The only fossil species hitherto recorded belonging to the genus *Pyrgoma*, are the *Pyrgoma undata*, of Michelotti,[2] from the Miocene Tertiary strata of northern Italy; and the *Pyrgoma anglicum* (Sowerby), from the Coralline Crag of Suffolk, which Dr. Darwin considers to be identical with the recent British species.[3]

The single fossil example we possess consists of about two-thirds

[1] Darwin Foss. Cirripedia, Pal. Soc. Mon., 1854, pp. 35, 36.

[2] Bulletin Soc. Géol., tom. ix. p. 141.

[3] Darwin Foss. Cirripedia, p. 36.



Cretaceous & Liassic Crustacea

of the circumference of the conical walls of the shell; the opercular valves and base being absent. It would be impossible to speak positively of such a fragment, were it not for the steeply conical form and the rounded approximate, radiating ribs, which mark the surface (Pl. XIV. Fig. 2*a*). Viewed from above the costæ are more rounded and less prominent than in the *Pyrgoma anglicum* (Plate XIV. Fig. 3), from which it also differs in its larger size and the greater thickness of the shell-walls, and the obliquity of the cone.

Diameter at base, 4½ lines; at apex, 1¼ line; height of shell, 5 lines.

The ribs are crossed, at regular intervals, by well-marked lines of growth, forming, with the costæ, a reticulated ornamentation on the surface of the shell-wall, there being seven rings of growth in the space of a line.

The shell, if perfect, would probably have displayed about twenty-five or thirty vertical costæ, and about thirty-five transverse rings. The interior of the shell is smooth, and the wall is nearly one line in thickness near its base. No sutures are visible, the parietes having, apparently, all coalesced in the adult, as is the case with the recent species of *Pyrgoma*.

M. Bosquet, of Maestricht, has already figured and described a species of *Verruca* from the Uppermost Chalk.[1]

Dr. Darwin has also shown that the species common to our Red and Coralline Crag, and to the Glacial deposits of Scotland, is identical with the living *Verruca strömia* of our British seas (Mon. Foss. Cirripedia, p. 42, T. 2, f. 9).

We have now another sessile cirripede, embracing the same range in time—in the case of *Pyrgoma*, not parasitic upon shells (like *Verruca*), but fixed to the cup of a coral; and it is interesting to find it associated with the same form of corals, both in the Chalk and in recent seas; serving as an excellent illustration of the principle, so universal in Natural History, that whenever conditions are the same, similar associations of animals recur, even through periods of time, far beyond our powers to estimate.

II. *Necrocarcinus tricarinatus*, Bell.—In Professor Bell's Monograph on the Crustacea of the Gault and Greensand (Palæontographical Soc. Mon. 1862, p. 19,) he adopts the name *Necrocarcinus* for certain forms of Crustacea, from the Chalk-marl and Upper Greensand, figured and described by him, and referred (not, however, without some doubt) to the family of *Corystidæ*. To this genus I wish now to call attention, and especially to the species *N. tricarinatus* (ib. p. 21). The examples figured by Professor Bell are from the Upper Greensand of Cambridge and of Wiltshire. "The margin of the specimen described," writes the author, "is much broken, so that we are left to speculate in some measure upon the exact figure of the carapace; but, following the line indicated by the portions which remain entire, it appears to be less uniformly rounded than in *Necrocarcinus Woodwardii*.

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[1] Verhandelingen Geologische Beschrijving en Kaart van Nederland. Haarlem, 1854. p. 12, Plate I., fig. 8–16.

Having lately obtained from the Gault of Folkestone the beautiful crustacean figured on Plate XIV. Fig. 4, I at first inclined to consider it a new species; but after a very careful comparison of it with Professor Bell's *N. tricarinatus*, I am led to conclude that it is only a more perfectly preserved specimen of that species than has been hitherto met with. It is, however, extremely valuable, as serving not only to complete the necessarily imperfect description of the species, but also to demonstrate that, in all probability, its affinities are with the *Portunidæ*, and not with the *Corystidæ*. But, on this point, however, we still need fuller evidence than that to be derived from the form of the carapace, of which, as yet, only the upper surface is known to us.

DESCRIPTION.—The specimen figured on our Plate measures 1¾ inch in greatest breadth, and 1¼ inch in length. The posterior margin is 8 lines in breadth and expands with a nearly straight border laterally to the epibranchial spine, where it is 1¾ inch broad. The latero-anterior border is rounded and is marked by 4 spines, in addition to the epibranchial spine. The orbits have two fissures in their superior margin. The nuchal furrow is distinctly marked and is divided into two branches, laterally, enclosing the hepatic region. Behind the nuchal furrow and separating the urogastric from the epicardiac lobe is a short, strongly-marked transverse cardiac furrow, 3 lines in length, which indents the median ridge or carina, and is then bent forward and outwards for about 2½ lines.

In decorticated or water-worn specimens (as in those figured by Professor Bell and on the right-hand side of the specimen figured in our Plate (Fig. 4), there is a curved sculptured line between the meso- and meta-branchial lobes strongly marked and resembling impressed letters. A distinct, but not very elevated, carina follows the median line, extending the whole length of the gastric region, and is only interrupted by the cardiac furrow; whilst another less strongly marked granulated ridge marks each branchial region, extending longitudinally on the middle of the meta-branchial lobe. The epigastric and protogastric lobes are marked by tubercles of moderate size; a somewhat larger and more prominent one is seen on each epibranchial, and three minute prominences mark the epicardiac lobe.

After a more careful comparison of Professor Bell's *Necrocarcinus Bechei* and *N. Woodwardii* with *N. tricarinatus*, one cannot but conclude that the two former species are generically distinct from the latter—*i.e.*, of course assuming that it is lawful to differentiate a fossil species of Crustacean upon the carapace alone, without a knowledge of the other parts.

The generic name applied to the original species described by Deslongchamps in 1836 (Mem. Soc. Linn. Norm. V. p. 40, t. 1, fig. 7–9), was *Orithyia Bechei.* The generic name *Orithyia* ought, therefore, to be re-habilitated for *Bechei* and *Woodwardii*, restricting *Necrocarcinus* to the species *tricarinatus.*

Sir H. T. de la Beche has figured an example of *Necrocarcinus tricarinatus* from near Lyme Regis, Dorset[1] (probably from the true Gault). Professor Bell records and figures it from the Upper Greensand of Cambridge and Wiltshire: the specimen in our plate is from the Gault of Folkestone. We have thus evidence of its occurrence in four well-marked British localities.

III. *Palinurina longipes*, Münst. [Plate XIV. Fig. 5].—In Count Münster's Beiträge zur Petrefactenkunde, 1839, Bd. II. p. 36, he proposed the genus *Palinurina* for certain species of Macroura

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[1] Trans. Geol. Soc., 2nd series, Vol. I. pl. iii. fig. 1, p. 42.

(having a general resemblance to the recent *Palinurus*) found in the Lithographic stone of Solenhofen.

In a paper by Mr. Charles Moore, F.G.S., published in the Proceedings of the Somersetshire Archæological and Natural History Society, vol. xiii. (Taunton, November, 1867), I have recorded the occurrence, among many others, of two species of *Palinurina* in the Upper Lias of Ilminster, identical with those occurring in the Solenhofen slates described by Münster—namely, *Palinurina pygmæa* and *P. longipes.*[1] I have now to record the occurrence of this last-named species in the Lower Lias of Lyme Regis, discovered by Mr. E. C. H. Day, F.G.S., late of Charmouth, and now of Columbia College, New York, U.S.

Description.—This elegant little Crustacean measures 2 inches in length, whilst the large and rigid antennæ are of equal extent with the entire body. The antennules, not clearly seen in the specimen (fig. 5*b*.) are 8 lines in length, and are divided above the third joint into two multi-articulate setæ of equal length; the outer pair of antennæ have three large and scabrous basal joints, 1 line in breadth, and 1¼ in length, succeeded by stout multiarticulate setæ 20 lines in length, apparently but little flexible, as they are always found lying nearly in a straight line.

The late Dr. Oppel has pointed out that the articuli of the antennæ in the Solenhofen specimens are fringed with very minute hairs:[2] these cannot, of course, be detected in our Lias example. The five pairs of thoracic limbs are all monodactylous, the first pair being the stoutest and somewhat shorter than the succeeding: they are all scabrous like the bases of the antennæ. The surface of the carapace and abdominal segments is finely granulated, the former having a row of rather larger granules arranged in pairs down its centre. The abdominal segments decrease slightly towards the telson, the first being 4 lines and the fifth 3 lines in breadth, by rather more than a line in length. The tail-plates, which were broad and well adapted for swimming, are but imperfectly preserved in any of the specimens I have examined.

Within the past few years an extremely large number of Crustacea have been met with in our Lias, common also to the Solenhofen stone: as many as seven genera and eight species being apparently found in both.

The persistence of such forms as *Eryon, Eryma, Glyphæa,* and *Palinurina* through the whole Oolitic series, seems clearly to demonstrate that having escaped total extinction in the Lower Lias sea, they migrated from time to time to more favourable areas, and thus were enabled to live on during the periods of time represented by the long series of deposits, from the Lower Lias to the Lithographic stone, in which so many are found fossil.[3]

EXPLANATION OF PLATE XIV.

Fig. 1. *Pyrgoma cretacea*, H. Woodw., Upper Chalk, Norwich (exterior view) natural size.
„ 2. *Pyrgoma cretacea*, interior view of the same; natural size.
„ 2*a*. „ „ portion of the shell, much enlarged, to show costae.
„ 3. *Pyrgoma anglicum*, Sby. (greatly magnified view), Cor. Crag, Suffolk.
„ 4. *Necrocarcinus tricarinatus*, Bell, sp. Gault, Folkestone; nat. size.
„ 5. *Palinurina longipes*, Münst., Lower Lias, Lyme Regis; nat. size.
„ 5*a*. Portion of one of the antenna magnified $\frac{3}{1}$ (after Oppel).
„ 5*b*. One of antennules magnified $\frac{3}{1}$ (after Oppel).

The above specimens are all preserved in the British Museum.

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[1] See also British Association Report for 1867, Third Report on the Structure and Classification of the Fossil Crustacea.

[2] See Oppel's Palæontologische Mittheilungen, etc., Stuttgardt, 1862, p. 86, Taf. 24, fig. 1*b*.; see also our Plate XIV., fig. 5*a*.

[3] See Brit. Assoc. Report on Foss. Crustacea, 1867. p. 46.

IV.—ON THE DEPOSITS OF PHOSPHATE OF LIME RECENTLY DISCOVERED IN NASSAU, NORTH GERMANY.

By D. C. DAVIES, Oswestry.

THE little duchy of Nassau, so recently annexed to the kingdom of Prussia, has long been famous for its mineral wealth. It yields yearly about 350,000 tons of iron ore, principally Hematite, and about half that quantity of Manganese. Of its natural mineral water from Seltzers it exports above a million bottles annually. In its north-western corner are the Brown-Coal deposits of the Westerwald; and to these sources of wealth must now be added more valuable and extensive deposits of phosphate of lime, which, though not long since discovered, have already attracted the attention of the leading agricultural chemists of this country. This discovery has its scientific attractions, as well as its commercial advantages; and, as I have lately had an opportunity of examining these deposits in detail, it may be of interest to the reader, if I record a few particulars concerning them.

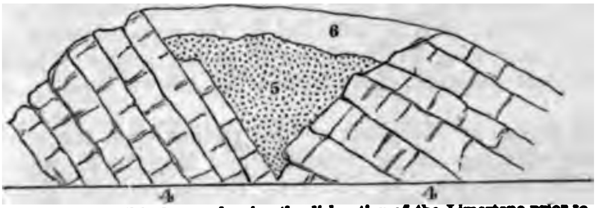
The principal phosphoritic deposits of Nassau occupy an irregular area, bounded on the north-east by the town of Weilburg, on the north-west by the Westerwald, on the east by the Taunus Mountains, and on the south by the town of Dietz. South of this point, as well as north-east of Weilburg, there are traces of the occurrence of the deposit; but, from the nature of the underlying rock, they will, I think, be found limited in their extent. Inside the eastern and southern boundaries of this district flows the river Lahn, which is made use of at various points along its course for the purpose of washing the Phosphorite from its surrounding clay, as well as for the carriage of the washed material to the junction of this river with the Rhine at Oberlahnstein. The basement rock of this district is porphyry, varying in colour from dark to light gray and green; the green is thickly studded with cavities, containing calcareous matter, which, after long exposure to the atmosphere, decomposes and disappears. Upon this rock, in its many varieties, rests a succession of slaty and shaly beds (schiverstein) which are greatly contorted and twisted; these again are overlaid by a great thickness of dark red sandstone beds, which, in places, contain deposits of Hematite. Over a large portion of the district these rocks are capped unconformably by a thick deposit of massive limestone (Dolomite), which ranges in colour from bluish gray to pink and bluish white. It is resting upon this limestone that the Phosphatic deposit is found; the whole series being crowned with a covering of brown clay (Tohn) which sometimes assumes a shaly appearance, and which also, in its upper portion, occasionally contains numerous fragments of the adjacent rocks.

These rocks have, by German geologists, been referred to the Devonian Group, an opinion which is strengthened by the similarity of the contour of the land to that of Devonshire. Some have even ventured to assign to each rock its exact place in the Devonian series; but the difficulty of co-ordinating these rocks with those of particular groups or subdivisions in England is increased by the entire absence of fossils; the only trace of one, observed by myself, being an ill-preserved fragment of coral in the red sandstone beds under the limestone.

The general appearance of the country is that of a large upland plain, with gentle undulations, out of which protrude, here and there, as the bone work of the country, great porphyritic masses, like the rocks of Weilburg, Merenberg, and Hof Beslich. This upland plain is also intersected by the valleys of the Lahn and its tributaries; but as you look across it from a sufficiently elevated point, these valleys are scarcely discernible, so sharply for the most part are they disrupted in the older rocks, or worn in the newer deposits. This smoothness of appearance is greatly helped by the way in which the inequalities in the older rocks are filled up by the deposit of Phosphorite and clay; but when we probe through this exterior padding, the inequalities in the surface of the rock become

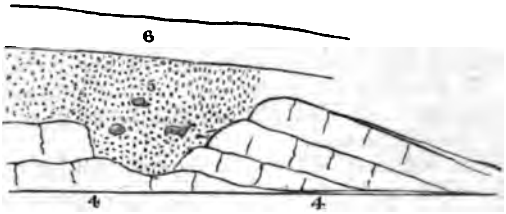
PHOSPHATIC DEPOSITS OF NASSAU.

FIG. 2.



Section at Staffel Nassau shewing the dislocation of the Limestone prior to the deposition of the Phosphate of Lime.

FIG. 3.



Section at Cubach Nassau illustrative of the rounding of the edges of the Limestone prior to the deposition of the Phosphate of Lime. The larger black spots are concretions of Manganese.

1. Porphyritic and Basaltic rocks generally crowned with a castle.
2. Shaly and Slaty beds (Schiverstein), much contorted and disturbed.
3. Red Sandstone beds.
4. Limestone Dolomite.
5. Deposit of Phosphate of Lime (Phosphorite).
6. Clay (Tohn).

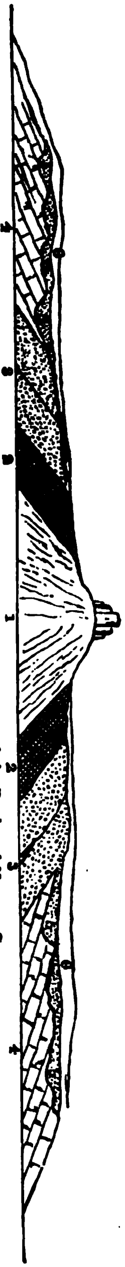


FIG. 1.—Section illustrative of the general geological structure of the Duchy of Nassau, Germany.

very apparent, and present indications of having originated, first, with dislocations of the strata before the phosphate of lime was deposited (Fig. 2), and, secondly, with long continued aqueous and atmospheric agencies; the first by means of currents scooping out grooves and miniature valleys, or by chemical action where the water lay still, wearing hollows in the limestone, and the latter slowly rounding the exposed edges of the beds (Fig. 3).

The deposit occurs in the form of concretions, imbedded in a matrix of clay; these concretions are most irregular in their shape, and vary in dimensions from the size of an apple to masses weighing two or three tons. It would also seem as if the original concretions had, subsequently to their formation, been subjected to a good deal of attrition: this is indicated by the preponderance of small fragments, decreasing in size down to that of grains of sand. Where the deposit assumes this form it is known locally as Washstein.

Besides this deposit of phosphate of lime resting upon the older rocks there are also deposits of Hematite and Manganese, which occur in just the same position, filling up the inequalities of the limestone. As far, however, as my observation went, these deposits are found in bulk around the outer margin of the phosphatic area. Smaller portions of these, however, either held in solution by the water in which all were deposited, or redistributed by currents, have become mixed up with the phosphorite (Fig. 3), and have also, in places, so permeated the latter as to reduce its per centage of phosphate of lime so low that its commercial value is considerably lessened. The Manganese and Hematite are also found in separate deposits within the phosphatic area.

Along the northern boundary, where the deposits border on the development of the older rocks, we find the greatest admixture of these extraneous matters, and the per centage of phosphate of lime ranging below sixty per cent.; but southward, towards Limburg, the deposit improves in quality, containing, in places, as much as ninety-two per cent. of phosphate of lime, and assuming the crystalline form of Apatite.

As might be expected from the mode of its occurrence, the deposit is most irregular in thickness, varying, even in the same mine, from six inches to as many feet. It appears to attain its greatest continuous thickness on a line ranging north-east and south-west, and thins out gradually to the north-west and south-east. To the north-west and west, the brown clay also becomes thinner, and is found covered with splintery gravel (Quartzgeschiebe), the detritus of neighbouring rocks. Hitherto the discoveries of phosphorite have been made only where limestone is the underlying rock. With the limestone, generally speaking, it appears to be co-extensive, its presence or absence, however, in particular places, will depend upon the presence or absence of deposits of iron ore or Manganese, as well as the possibility of its having suffered denudation in exposed places since its deposition.

To the enquiry, whence came such an amount of phosphatic matter, several answers have been given. It has been supposed to be derived from immense shoals of fish and other organisms, which crowded the shallows of this limestone sea, and whose remains were deposited in hollows and crevices of the rock. It has also been suggested that the phosphorite owes its origin to the action of carbonic acid water springs, bringing up phosphoric acid, or phosphate in solution from the older strata below; and, yet again, that the phosphate was dissolved out of the porphyritic rocks on the surface by the action of carbonic acid water; and that the absence of fossils from the deposit clearly shows that it is not composed of the remains of organic life deposited upon the sea bed.

In considering these suggestions it will, I think, be evident that the phosphatic matter was, in either case, derived originally from the older rocks, either by the action of springs from below, or by the decomposition of rocks on the surface; for we have already seen how full of calcareous matter, in some shape or another, some of those older rocks are, and that they bear traces also of a considerable amount of decomposition. Then the matter might also be derived largely second hand from the remains of former organic life deposited in the neighbouring subjacent rocks. The question then which remains to be decided is, whether this matter derived from the older rocks in various ways, and held in solution by the water, was deposited pure and simple, or whether it was not taken up first into organic forms, and afterwards deposited as the remains of these upon the ocean floor? No fossils are found in the deposit, but it is possible, it may be even probable, that, if there had been organic life, the structure of its remains would become destroyed by chemical action, just as I have elsewhere shown that the distinctive structure of the organic remains, which so largely compose the bed of phosphate of lime which occurs in the Bala limestone of North Wales, has been almost completely destroyed.[1] Indeed, such a supposition appears to me more reasonable than that of a lifeless sea resting upon a limestone bed. Without saying therefore that all the phosphate of lime derived from the older rocks was absorbed into organic life we may suppose that there was life in the sea of that period, and that, in some measure, these phosphatic deposits are the remains of that life.

To what geologic period do these deposits belong? Two answers have been given to this question; the one refers them to the age of the Lower Devonian beds, and regards them as the remains of Devonian fishes; and the other assigns to them a Tertiary date. The latter supposition is, I think, the one most in accordance with the general features of the deposit. For, an immense period must have elapsed after the deposition of the limestone to admit of the extensive denudation of the surface, often through unbroken strata, which took place before the phosphorite began to be deposited; a period of sufficient length, as it appears to me, to bring the deposition down to a much later period than that of the Devonian. And then if we consider the comparative softness of the deposit and its overlying clay, with the fact that, together, they do not attain a maximum thickness of eighty feet—oftener less than forty—we shall see how improbable it is that such deposits could resist all the geological changes, with their disturbing, abrading, denuding forces, from Devonian times until now. In the manner of its occurrence, as well as in its stratigraphical position, the deposit appears to me to be analogous to the deposits of white clay, which Mr. Maw has recently described as lying in pockets and hollows of the carboniferous limestone of North Wales, just below the mass of sands, gravels, and clays of the Glacial epoch.[1] To that epoch I think the clay and gravel overlying the Nassau phosphorite must be referred, and from the way in which this deposit is interlaced, dovetailed and mingled with the lower portion of the clay, I am led to regard it as a Tertiary deposit, whose formation immediately preceded the somewhat indefinite period which we term Glacial.

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[1] GEOLOGICAL MAGAZINE, 1867. Vol. IV., p. 251.

It may be interesting to note that the absence of boulders of any considerable size, either foreign or local, from the clays and gravels of Nassau appear to confirm the opinion of the late Edward Forbes, that, at a point not far south of England, the severe climate of the north passed rapidly, even during the Glacial epoch, into one much warmer.

The discovery of large stores of the raw material at a time when superphosphates of lime are so largely in demand for agricultural purposes, must be of great importance, and already considerable quantities of the Nassau phosphorite have been shipped to this country for use in the manufacture of artificial manures,—if, indeed, it be true that the lapse of time makes that artificial, which was as natural in its origin as the phosphates of yesterday.

V.—Kitchen Midden on Omey Island, Co. Galway.

By H. Leonard, F.R.G.S.I., of the Geological Survey of Ireland.

OMEY is a half-tide island off the coast of Galway. It is chiefly a Porphyritic Granite rock, on the north-west portion of which are wind-blown sands that are for ever changing their positions, the houses of the inhabitants being covered to such an extent by them, that, in order to reach the interior, they are compelled to descend through holes, like large rabbit-burrows. The oldest record we have in connection with the island is, that St. Fechin built an Abbey there previous to A.D. 664. This abbey is said to be buried in the sands, but its exact site cannot be pointed out; however, there is a supposed fifteenth-century church, that is now sunk 12 feet deep in the sand.

The *Kitchen-Midden* or shell-heap (the subject of this paper) is situated on the south shore of a small bay, which indents the western shore of the island; and opposite to which, on the north shore, is a very ancient well, dedicated to St. Fechin. The shell-heap is 50 yards long, by 20 yards wide, and presents at the sea-cliff the following section :—

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[1] Geological Magazine, 1867. Vol. IV., pp. 241 and 299.

	feet	inches
5. Sandy soil...	0	3
4. Bed of shells, calcined boulders with pieces of charcoal, bones, etc.	3	0
3. Brown sand	0	11
2. Dark sandy soil, containing some *Patella vulgata*	0	5
1. Fine white shell sand	9	0

The principal shells composing it are :—

Patella vulgata, limpet	about	·5
Litorina litorea, periwinkle	„	·3
Cardium edule, cockle	„	·2

which are in about the proportions marked to each; "razor-shells" (*Solen siliqua*) were also observed, besides bones of sheep, pigs, and fowl; there were also traces of fires, consisting of ashes, burnt stones, bones, and shells. At the present day the sea-weed gatherers may be seen cooking shell-fish, by placing them on a stone that they had previously heated to redness in a fire; and many of the stones here found may have been similarly used, as they are usually flattish, roundish boulders from four to seven inches in diameter.

The Midden appears to have extended further seaward, as now the deepest part is at the cliff, from which it gradually gets shallower, till it reaches its southern limits. As no implements of any kind were found here, the age of this shell-mound cannot be easily estimated. It may, perhaps, be of a comparatively recent origin, and in some way connected with the holy well previously mentioned, which is supposed to have miraculous properties, and is still visited by the credulous, who remain in its neighbourhood all night, while "performing their stations" at it. A little north of this heap and east of the holy well, is a thin surface heap of *Patella vulgata* and *Solen siliqua*, with bones, etc., many of the latter are broken, seemingly to obtain the marrow.

My colleague, G. H. Kinahan, M.R.I.A., writing on this subject, says as follows :—"I have remarked many shell-heaps or Kitchen-Middens near the shores of Galway Bay, some of which may be ancient, while others are undoubtedly modern. Those on the headlands, enclosing the different small bays to the east and south, are nearly altogether of *Ostrea edulis*,—however, there is one at the east end of Lough Atalia, formed altogether of *Mytilus edulis*, but this is quite modern only now being formed by the inhabitants of the east suburbs of Galway. The largest of the oyster-heaps seems to be that of Creggauns, the headland next south of that of Ardfry, the seat of the Lords Wallscourt. This heap is now only 210 feet long, 70 feet in its widest part, and about 8 feet deep, its base being two feet below high-water-mark of mean spring tides; the principal shells in it are those of the *Ostrea edulis*, but in places there are quantities of *Mytilus edulis*, others also occur but none in remarkable quantities. An excavation was made partly across this heap by Dr. Buckland and myself, without finding any implements; but on the shore among the shells, were picked up two flake-like implements made of hard limestone.

These seem to have been knives for flaying animals, but as stone knives have to a very recent period been used on the Islands of Arran for similar purposes, these cannot be relied on to prove the antiquity the Midden, more especially as there is a tradition that formerly the oysters were shelled at stations along this coast, previous to being preserved for foreign consumption; and what gives a colour to this tradition is, that in the neighbourhood of the Kenmare River, the same tradition is found in reference to the heaps of oyster-shells which occur there also. If this is the true history of these heaps, might not the ashes found in such quantities among the shells be the remains of the fires used in the preserving process.

On the islands near the entrance to the Bay, the principal shells in the heaps are *Patella vulgata* and *Litorina litorea*. On Gorumna, in the vicinity of the church called Ballynakill Abbey, there is a large heap composed of these shells, with some bones of the cow, sheep, pig, etc., and on the east shore of Greatman's Bay there is a remarkable Midden 50 feet in diameter, 15 feet high, and forming a flat-topped hillock, composed seemingly entirely of the shells of the limpet and periwinkle. On the Arran islands, heaps are very numerous, some near the old Pagan, and more near the early Christian dwellings, while others are in the vicinity of what may have been, comparatively speaking, modern erections; among the latter, being one on the middle island, in which a coin with the date 1610 was found, among the more ancient, may be those near Dubhcaher (*anglice* black city), supposed to be the oldest settlement on the islands, and to have been inhabited previous to the Christian era; but what is probably the most ancient, is one lately discovered by the Rev. W. Kilbride, Vicar of the Island, which has been buried for ages under the sand-hill on the south of Killany Bay—as I have not seen this, I cannot give you any information about it."

From this it will be seen that the heaps are probably of all ages, some being of modern construction—more of medieval age—while others may be very ancient. In favour of the last supposition, it may be mentioned that W. Harte, Esq., F.R.G.S.I., has explored and described various very similar Kitchen-Middens on the coast of Donegal, in which the only implements found were made of stone. (*See Dublin Quarterly Journal of Science, Vol. IV.*, *p.* 189 *et seq.*).

VI.—NOTES ON CRETACEOUS BRACHIOPODA AND ON THE DEVELOPMENT OF THE LOOP AND SEPTUM IN TEREBRATELLA.

By C. J. A. MEŸER, ESQ.

IN a paper on "Cretaceous Brachiopoda," published in the first volume of the GEOLOGICAL MAGAZINE, page 249, I noticed the occurrence of a species of *Waldheimia* in the Lower Greensand of Surrey, under the name of *Waldheimia Moutoniana*, which at the time appeared to me to answer to the figure and description of *Terebratula Moutoniana* of D'Orbigny.

The identification of this species has been, however, severely criticised by Dr. Schloenbach, of Salzgitter (Hanover)[1] who states that D'Orbigny's *Terebratula Moutoniana* possesses the short loop of a true *Terebratula*.

Such being the case the so-called "*Waldheimia Moutoniana*" figured by Mr. E. Ray Lankester in the "Geologist," vol. vi., pl. xxi., figs. 1-4, and subsequently by myself in the GEOLOGICAL MAGAZINE (Vol. I., Pl. XII., Figs. 12-14), becomes a new species, for which I suggest the name of *Waldheimia Morrisii*.

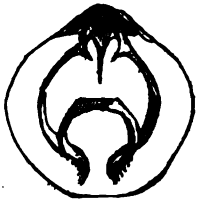
I append the following description:—

Waldheimia Morrisii, sp. nov. (GEOL. MAG., Vol. I., Pl. XII., Figs. 12-14).[2]

Shell ovate or oblong-ovate, slightly tapering towards the beak. Valves convex, deepest towards the posterior portion of the shell. Beak slightly incurved and truncated by a moderately sized foramen. Beak-ridges sharply defined, producing a slightly flattened hinge-area. Foramen semicircular above, pointed below where completed by the two, almost triangular, plates of the deltidium. Larger valve almost regularly convex, more abruptly so near the beak. Dorsal valve less equally convex, much depressed at the sides, elevated in front, and sometimes exhibiting a narrow longitudinal depression near the frontal margin of the shell, as in *Terebratula ovata*, Sow. Loop much elongated, extending to near the front of the shell before becoming reflected. Septum short and but slightly elevated.

Length 10, width 7, depth 4½, lines.

This species differs from *Waldheimia celtica*, Morris, in the comparative breadth of the valves, and still more conspicuously in the curvature of the shell-margin, which in *Wald. celtica* is always nearly straight.



Loop of an old specimen of *Waldh. tamarindus*, Sow.

From *Waldheimia tamarindus*, Sow., its nearest ally in the Greensand of Shanklin, it differs not only in the size and proportion of its valves, but also in the shape of the reflected portion of the loop.

From certain peculiarities observable in the loop of *Waldheimia tamarindus*, Sow., Dr. Schloenbach proposes (in the paper above referred to) to place that species under the section *Megerlia*, King. Yet after a long and careful examination of the interiors of a considerable number of specimens of *Waldh. tamarindus*, I am unable to perceive that its loop ever approaches sufficiently to that of a *Megerlia*, to warrant the removal of the species out of the section in which it has been placed by Davidson.

The arrangement of the loop and septum of *Waldh. tamarindus* (as seen in examples from the Lower Greensand of Shanklin), may be described as follows:—

Loop elongated and recurved. The produced portions (lamelles ascendantes. Eug. Desl.) extend (both in young and old examples) to very near the front of the shell before becoming reflected. The reflected portions (lamelles recurrentes) return back to about the middle of the shell, and form an arched or rounded loop, not unlike the same portion of the loop in the recent *Waldheimia cranium*.—Müller.

In old specimens certain spinose projections occasionally make their appearance on the sides and on the extreme front of the loop—

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[1] Zeitschr. d. deutschen geologischen Gesellschaft, 1866.

[2] The numbering of Plates XI. and XII. in Vol. I. of the GEOL. MAG. was accidentally reversed by the engraver.

as in *Terebratula resupinata*, Sow.,—and these, by projecting sideways or towards the edges of the shell, give the loop a somewhat unusual appearance. See fig. ante p. 269.

The septum of *Waldh. tamarindus*, except in young examples, is short and but little elevated, and remains always unattached to the loop. The inner surface of the shell is smooth, and never spinose, as in *Megerlia lima*, Dav., and in the recent *M. truncata*, Gmel.

In this description there is nothing to suggest the double (?) attachment of the loop to the septum, which forms so marked a feature in the section *Megerlia*. But Dr. Schloenbach, if I understand him aright, has applied to the section *Megerlia*, the theory of development of the loop and septum, which was (some years since) suggested by Mr. Chas. Moore as applicable to the genus "*Terebratella*," D'Orb. (Geologist, vol. iii., pl. xiii., "On the development of the loop in *Terebratella*"). And the question whether *Waldh. tamarindus* is or is not a *Megerlia* depends therefore mainly on the real *mode of development* of its loop and septum.

In the figures given by Mr. C. Moore (see Geologist, vol. iii., pl. xiii., figs. 1-4) representing several stages in the development of the loop in the genus *Terebratella*, the loop is represented as being *free* or unattached to the septum in the three first stages of its growth, and attached only in the fourth or complete state. The septum—in the same figures—is also apparently *absent or undeveloped* in the earlier stages in the growth of the loop.

But this description, in so far as regards the *absence* of the septum and the *free* condition of the loop in its earlier stages, is so entirely at variance with my own observations amongst the Cretaceous species of *Waldheimia* and *Terebratella*, that I cannot but suspect some error of observation or delineation in the examples figured, arising perhaps from the minuteness of the specimens from which Mr. C. Moore's figures were obtained.

Now I have mostly observed that the septum in the sections *Waldheimia*, *Terebratella*, and *Megerlia*, is comparatively much longer and more largely developed in the extreme young and half grown, than in the adult shell,—as for instance in *Megerlia lima* and *Terebratella Menardi*, and that it even reaches in some cases the whole length of the smaller valve, as in some half-grown examples of *Terebratella trifida* now before me.

From these and many other examples which I could mention, it would appear that the growth of the septum is at first strictly coextensive with the growth of the shell until the former has attained to nearly its greatest length, and that it increases afterwards only in height and thickness. And further that a septum is seldom if ever produced for the first time in a full-grown shell.

The attachment of the loop to the septum in the young of *Terebratella* does not, unfortunately, so readily admit of proof owing to the difficulty of obtaining perfect specimens.

In examining the interiors of various species of *Terebratella*, I have, however, frequently observed that the septum itself exhibited what appeared to be unmistakable evidence of the continuous attachment of the loop. This evidence consisted in the occurrence of a curved line or ridge extending on the sides of the septum from its origin beneath the hinge-plate to the point from whence the transverse processes then proceeded for the attachment of the loop. And as such ridges are not observable in any species of *Waldheimia* with which I am acquainted, they may, I imagine, be regarded as the remains of former processes from the septum, indicative of the attachment of the loop from its earliest development.

The condition of the loop and septum in some very young specimens of *Terebratella Menardi*, in my collection, fully tends to support this evidence.

In these examples the septum is much elevated, and extends to nearly the front of the smaller valve. The descending portions of the loop, which diverge from the hinge-plate in the usual way, are broadly attached to the septum near its extremity, and bending sharply rise in an almost inconspicuous ridge above the septum.

From this stage of the loop its development would probably follow what appears to me to be *the natural law of increase in the loops of Brachiopoda*, namely, the gradual absorption of the inner edges of the loop, and the increase of its outer or upper edges by the secretion of fresh shelly-matter from a portion of the lining membrane of the shell.

With regard, therefore, to the attachment or non-attachment of the loop *at different ages of the shell* in the sections *Waldheimia*, *Terebratella*, etc., the rule appears to be that the loops are either constantly attached to the septum—as in *Terebratella*, *Megerlia*, etc., —or constantly free, as in *Waldheimia*. And although the exception may hold good as regards the young of *Terebratella Buckmanii*, Moore, I am sure that such is not the case with regard to *Wald. tamarindus*, Sow.

By grinding down or in other ways partially removing the matrix from the interiors of the valves, I have succeeded in obtaining dissections exhibiting the loops of most of our Cretaceous Brachiopoda, and amongst others of the following species, the loops of which have not, I believe, been as yet described.

1. *Terebratula ovata*, Sow. Loop short and simple; no mesial septum.
2. *Terebratula rugulosa*, Morris. Loop short and simple; no mesial septum.
3. *Terebratula squamosa*, Mant. Loop short and simple; no mesial septum.

The discovery of the loops of these three species has given me much pleasure, as tending to prove the correctness of Mr. Davidson's observations respecting the small *generic* value of surface-markings on the valves of Brachiopoda.

4. *Terebratula Carteri*, Dav. Loop short and simple.
5. *Waldheimia Boubei* (?) D'Archiac. (*Ter. faba* (?) (Sow.)[1]

Loop much elongated and reflected. Frontal extremity of loop studded with irregular spines, as in *Terebratula resupinata*, Dav. Septum short and but little elevated.

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[1] Figured in GEOL. MAG., Vol. I., Pl. XII., Figs. 5-7.

Of this somewhat doubtful species I have several examples from the Lower Greensand of Folkestone and Godalming. The Folkestone specimens are filled with silex, and possess the loop in the most perfect state of preservation. It is interesting to observe that the loop in these specimens approaches as near to the front in the young and half grown as in the adult shell.

6. *Terebratella oblonga*, Sow. Loop elongated and reflected, doubly attached; mesial septum (in the adult shell) reaching to nearly the middle of the smaller valve.

VII.—DISCOVERY OF GAULT WITH PHOSPHATIC STRATUM AT UPWARE.

By H. KEEPING, Assistant Curator of Woodwardian Museum, Cambridge.

HAVING frequently visited Upware during the past fourteen months, for the purpose of collecting from the Lower Greensand, in which I have been very successful, having obtained for this Museum a beautiful and choice collection, I have had every opportunity of observing the progress of the excavations, and of noting the relative position of the beds.

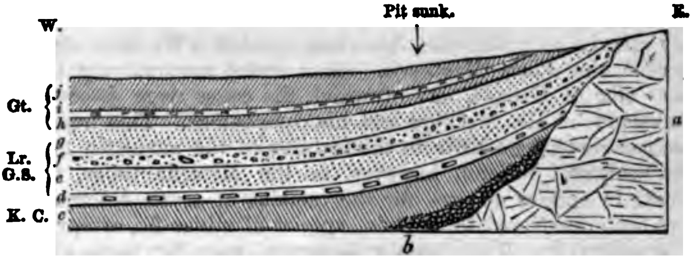
When there in February last, I picked up a phosphatised specimen of *Ammonites interruptus* at a short distance from the cropping-out of the Coral-rag. This led me to believe that the Gault might be found; accordingly, on the 24th of March last, I sunk a pit. After passing through about seven feet of clay I came to a phosphatic bed, from which I collected the following fossils, proving, I believe, the whole to be Gault:—

Ammonites serratus,	*Nucula ovata*,
Ammonites interruptus,	*Nucula pectinata*,
Baculites ,,	*Dentalium ellipticum*,
Belemnites minimus,	*Inoceramus concentricus*.
Belemnites attenuatus,	

The pit sunk was about ten feet in depth. The phosphatic-bed (see *i*, in section) from which the fossils were derived averages five inches in thickness. After passing through another foot of the non-fossiliferous Gault I entered the Lower Greensand (*g*), and on sinking two feet lower the rising of the water compelled me to desist.

It will be seen from the section that the Kimmeridge Clay is unconformable to the Coral-rag; and it would appear that, at the time of the deposition of the Kimmeridge Clay, a quantity of its broken and often rounded fragments became intermixed with it, so that in the vicinity of junction it actually presents the appearance of Boulder-drift. This was at first puzzling, but when the position of the bed was determined it was seen to be a natural consequence.

The collection of fossils obtained is small, but, considering that it is the production of a pit of about a yard square, they are as numerous as we can expect; the distinct species being eight, and there are many specimens. Although the Gault has been found in this country, few fossils have been met with in it, and I know of no other collection that will compare with this, neither is there, to my knowledge, any other locality within the same district which gives so good a sequence from the Coral-rag to the Gault.



Section of Strata at Upware on the Cam.

a Coral Rag *in situ*.
b Coral Rag intermixed with Kimmeridge Clay (the bed marked (*b*) extends as high up the denuded surface of *a* as the deposit marked *h* although not shown in the diagram.)
c Pure Kimmeridge Clay.
d Lower phosphatic bed of Lower Greensand, rich in fossils and often cemented so as to form hard conglomerates, and containing a large quantity of derived fossils.
e Lower Greensand, with few or no fossils.
f Upper phosphatic bed of Lower Greensand.
g Upper layer of Lower Greensand.
h Gault of about one foot in thickness.
i Phosphatic bed in Gault of five inches in thickness.
j Non-fossiliferous Gault, seven feet.

NOTICES OF MEMOIRS.

I.—On the Miocene Flora of the Polar Regions. Two Lectures given at the Annual meeting of the Natural History Society of Switzerland on the 9th and 11th September, 1867, at Rheinfelden, by Professor Oswald Heer, of Zürich.

(Translated by John Edward Lee, F.S.A., F.G.S.)

I.

PROFESSOR HEER has had the opportunity of examining a large number of fossil plants from the museums of Dublin, London, Copenhagen, and Stockholm, which have been discovered in the north of Canada (on the Mackenzie), in Banksland, in North Greenland, in Iceland, and in Spitzbergen. They reveal to us valuable information both as to the diffusion of plants in the early ages of the world, and also as to the climate which prevailed at that time in the far north. This Arctic Miocene flora, so far as can be ascertained from these specimens, consists of 162 species:[1] 18 species belong to the cryptogamia, and amongst them we notice small fungi, which have formed spots and dots on the leaves of trees, just as the leaf-fungi do at the present day; and 9 species of fine large plants of the fern tribe, with which the ground under the forests was probably clothed. The phanerogamous plants consist of 31 species of trees allied to the fir tribe, 14 monocotyledons, and 99 dicotyledons. Judging from their analogy with the nearest living plants, there were 78 kinds of trees, and 50 shrubs: consequently, at that period, 128 species of woody plants had been diffused over the far north. Amongst the pine or fir tribe we find silver firs (Tannen), spruce firs (Fichten), and common or Scotch firs (Föhren)—most of which very nearly approach the American species. We may especially mention the *Pinus MacClurii*, which looks uncommonly like the *Pinus alba* of Canada, and of which the cones were discovered in Banksland by Mr. McClure and his companions. This tree, doubtless, contributed no little to the features of the mountain forests of that country. Iceland, however, in the Miocene times, was the richest in species of pine, for the remains of seven different kinds have been discovered there—viz., species of silver fir, of spruce and of common fir. The *Sequoiæ*, however, were far more abundant than the pines; and, in the Miocene times, it can be proved that they were very abundant in Europe, Asia, and America; while at the present day this genus is confined to California. Only two living species are known (*S. sempervirens* and *S. gigantea*)—the last survivors of this remarkable type of plants, which contains the greatest trees in the world. In the Miocene times four species lived in the polar regions; three of which, however, were spread over middle Europe. The *Sequoia Langsdoffii* is the chief tree of North Greenland; and not only branches with leaves upon them, but even the flowers, the cones, and the seeds, have been discovered. In the Miocene age it lived also in North Canada and in Vancouver's Island; and, on the other hand, it can be proved also to have existed in Germany, Switzerland, and Italy. It is uncommonly near to *Sequoia sempervirens*, and is only distinguished from it by the cones being somewhat larger. The *S. Sternbergi*, which was very abundant in Iceland, is, on the other hand, closely related to *S. gigantea* (the "*Wellingtonia*"); while the *S. Couttsiæ*, which is found at Disco and Atanekerdluk, fills up the gap between *S. Langsdorffii* and *S. Sternbergi*. The trees allied to the cypress are largely represented; and we find three genera, *Taxodium*, *Thujopsis*, and *Glyptostrobus*. The home of the two last is in Japan, while that of *Taxodium* is in North America. The *Glyptostrobus Europæus* had precisely the same range as the *Sequoia Langsdorffii*; and the same may be said of *Taxodium dubium*; of which twigs, leaves, and cones were found at Atanekerdluk, and its remains were found in Spitzbergen, even at Bell Sound (nearly 78 degrees north lat.). The *Thujopsis Europæa* (a kind of evergreen) is much rarer, and yet very pretty branches of it were found in Northern Greenland, which agree with those found in amber, and at Armissan (Narbone). Amongst the *Taxinæ* may be especially mentioned a *Salisburea* from Greenland, as this genus at present grows wild only in Japan.

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[1] These species are described and drawn in the work of Professor Heer, Ueber die fossile Flora der Polarlände." Zürich; Fr: Schulthess, 1867.

The number of foliaceous trees of the Arctic zone in Miocene times was so great, that only a few species can be specified here. Many of them are very similar to those of our own country; as, for instance, the beech and the chestnut, which are found in North Greenland up to 70 degrees north lat. One kind of beech, *Fagus Deucalionis*, was very nearly related to our common species: the leaves have the same form size, and nervation, but the edge in front is dentated. It was apparently diffused over the whole north, for it can be proved to have existed in Greenland, Iceland, and Spitzbergen. The species of oak are found in still greater variety: there were eight kinds in North Greenland; most of them had large leaves, beautifully indented, and they bear the greatest resemblance to American species. One of them (*Quercus Olafseni*), which can be traced from Northern Canada to Greenland and Iceland, corresponds with the *Q. Prinus* of the United States. A plane tree also (*Pl. aceroides*) had spread over all these countries—nay, was found even in the Icefiord of Spitzbergen. Numerically, however, the poplars were far more abundant than the beeches, the oaks, or the planes. Two species (*Populus Richardsoni* and *P. arctica*), together with the *Sequoia Langsdorfii*, were amongst the commonest trees of the polar zone, and can be traced from the Mackenzie to Spitzbergen. It is a striking fact that very few remains of willows are found, while at the present day willows form one-fourth part of the ligneous plants of the Arctic zone. Birches were abundant in Iceland; and a tulip tree, and a maple with large berries (*Acer otopteryx*), also flourished there. Remains of the walnut tree; of a coriaceous-leaved *Magnolia;* and of a *Prunus* (*P. Scottii*) came from Greenland: and a large-leaved lime-tree was found in Spitzbergen (*Tilia Malmgreni*): its leaves were found at Kingsbay in 79 degrees N. Lat.

These types of trees, which approach those of living species, are accompanied with others of a different kind, the determination of which is somewhat difficult. One species with remarkably large coriaceous leaves (the *Daphnogene Kanii*), belongs probably to the *Lauraceæ*, and four others (*Mc Clintockia* and *Hakea*) to the *Proteaceæ*. It is doubtful whether the last-named plants took the form of trees or shrubs; the others, judging from the analogy of living forms allied to them, very probably were the shrub-growth of that age. To these may be added a species of hazel (*Corylus M'Quarrii*), which was spread over the whole of the north, and is found in Spitzbergen, even 78 degrees N. Lat.; also an alder (*Alnus Kefersteinii*), which was diffused equally far and wide. From Greenland up to 70 degrees N. Lat., we know of species of buckthorn (*Rhamnus*), *Paliurus*, *Cornus*, *Cratægus*, *Ilex*, *Andromeda*, and *Myrica*. Climbing plants also were not wanting. A species of ivy (*Hedera M'Clurii*) was found on the Mackenzie and in Greenland; there were also found here the remains of two kinds of vines, and a third flourished in Iceland. All three correspond with American forms.

It would not be difficult, from this list of species, to draw a picture of the vegetation in these high northern latitudes; it would show us a mass of foliage of various tints, made up both of pines and other forest trees—trees with great leaves of varied forms, their stems twined round with vines and ivy, and under their shade there are numerous shrubs, mixed with elegant ferns.

How very different is the picture now presented to us in the polar regions! At the present day an enormous glacier covers Northern Greenland, leaving only a narrow strip of coast free from ice in the summer, and this glacier every year sends out into the ocean thousands of icebergs, which lower the temperature of the southern latitudes; but at one period this very country was covered with a luxuriant primæval forest, composed of a great variety of trees, such as we now find only in the warmer parts of the temperate zone! In fact we find *Taxodiæ* and plane-trees in Spitzbergen in 78 degrees N. Lat., nay even a lime-tree and a poplar in 79 degrees N. Lat., consequently only 11 degrees distant from the pole. The lime-trees, the *Taxodiæ*, and the plane-trees may here have reached their most northern limits; but this was certainly not the case with the firs, and the two kinds of poplar, which were living in Spitzbergen; for we know that at the present day firs and poplars go 15 degrees further north than plane-trees. There is no ground for doubting that it would be the same in the Miocene ages; and if so, these trees will have reached the pole, provided land then existed there. The Miocene limits of trees were therefore very different from those of the present day. This was made very evident by a glance at a large map of the Arctic zone, exhibited by Professor Heer, on which he had laid down the limits of trees; he pointed out that this boundary coincides with the July isothermal of 10 degrees centigrade (50 Fahr.): this falls under the normal parallel of 67 degrees N. Lat., so that at present the normal limit of trees is but a short distance within the polar circle, while in the Miocene age it reached to the very pole. This indicates a great change in the climate, and this was proved more definitively by the lecturer from the evidence given by the fossil flora of Spitzbergen and Greenland. From the character of the specimens brought from Spitzbergen, he concluded that it must, in 79 degrees N. Lat., have had at that time a mean annual temperature of 5 degrees cent. (41 Fahr.). He had formerly estimated that in those ages Switzerland must have had a mean temperature of 21 degrees cent. (69.8 Fahr.), so that the difference between the two is 16 degrees cent. (28.8 Fahr.), or a decrease in going northward of 0.5 cent. (0.9 Fahr.) per degree. According to this calculation we should have in Spitzbergen, in 78 degrees N. Lat., an annual temperature of 5.5 cent. (41.9 Fahr.), and in Greenland, at 70 degrees N. Lat. an annual temperature of 9.5 cent. (49.1 Fahr.); but in Iceland, and on the Mackenzie, in 65 degrees N. Lat., the temperature of 11.5 cent. (about 53 Fahr.), which enables us to explain all the phenomena in the vegetable world just described.[1] At present the difference of temperature between Switzerland (in 47 degrees N. Lat., and calculated at the level of the sea) and Spitzbergen (in 78 N. Lat.) is 20.6 cent. (37.08 Fahr.), which gives a difference per degree of 0.66 cent. (1.188 Fahr). In the Miocene times, therefore, the warmth was more equally distributed, and the diminution of heat in advancing to the north was much more gradual, so that consequently the isothermal of zero (cent., 32 Fahr.) fell under the pole, while at the present day it comes down to 58 degrees N. Lat.

Lastly, the lecturer controverted the opinion that these plants had been floated, or brought by water, from a great distance to the arctic zone. This cannot possibly have been the case, for the leaves are in beautiful preservation, and lie together in great masses: they are found in connection with great beds of coal; and amongst the specimens there are flowers, fruits, and seeds (nay, even berries themselves), and young, tender, and even unfolded beech leaves; and moreover, insects are found with them. Any one who, with a sound, unprejudiced mind, looks over the great variety of specimens of plants so beautifully preserved as those which fill the rocks of Atanekerdluk, in Northern Greenland, must come to the conclusion that they came from the immediate neighbourhood: in addition to which, the fact that the Spitzbergen plants are found in a fresh-water formation is a decisive proof that they were not the waifs of the sea.

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[1] This is fully shown in the "Fossilen Flora der Polarländer," by Prof. Heer, p. 72.

II.

Professor Heer having been asked how he could explain the great change of climate indicated by the Miocene flora, gave a second lecture on this particular subject. In the first place, he discussed the conditions of the globe itself, which here come into consideration. A change of the pole, in the way which has lately been brought forward by Mr. Evans, is opposed by the fact that both in the Arctic zone and in the more southern latitudes, the same phenomena are observable all round the globe. We nowhere find indications of the pole having been displaced; and we cannot, therefore, ascribe the change of climate to any such cause. Much greater weight seems due to the idea that the climatic changes have arisen from a new distribution of land and water on the earth's surface. At the present time the proportion of land to water is about as 1 to 2½. The greater part of the land is in the northern hemisphere, more especially in that part of it which is beyond the tropics. The earth, therefore, at the present moment is in an abnormal condition: what we should consider as the normal condition being a proportionate distribution of land and water over every zone of the earth, by which the temperate and cold zones would enjoy a warmer climate than they do at present. But even if we could imagine such a favourable apportionment of land and water, we should still not find such conditions as would enable us to extend the flora before mentioned from 70 to 79 degrees N. Lat. If we were to place all the main land under the tropics, and only a few islands in the north, the latter would, indeed, have the highest possible medium annual temperature, and the winters would relatively be very mild, but the summer heat between 70 and 80 degrees N. Lat. never could rise so high as to produce so rich a forest flora. Besides this, there was apparently in the Miocene age a great quantity of main land in the temperate zone of the northern hemisphere, and it must also have extended a considerable distance into the polar regions, as may be proved by the spread of the Miocene plants; for many kinds of trees and shrubs may be traced from the Mackenzie through Greenland up to Spitzbergen. Had there been only some scattered islands in the arctic zone at that time, these plants would never have spread so far.

Great stress was some time since laid on the internal heat of the globe, and it was thought that this might account for the higher temperature of the early ages of the world. But even if this may with some probability be thought to apply to the oldest periods, it cannot do so to the Miocene times, for they come so near to our own age, that we cannot venture to attribute to such a cause so great a difference of temperature. It is, therefore, not possible to explain this great change of climate from the conditions of our globe, at any rate from those which are at present known to us.

We must, therefore, turn to cosmical conditions, and see whether we can find in them the solution of the enigma. We may take into consideration the changes in the position of the earth relative to the sun—in the intensity of the sun's rays, and in the temperature of the universe.

With respect to the first, great stress has lately been laid on the periodical changes in the eccentricity of the earth's orbit. It is well known that this is not a circle, but that it forms an ellipse, in consequence of the influence of the larger planets. The form of this ellipse changes within certain limits in the course of thousands of years. At the present moment the earth's orbit is gradually approaching the form of a circle, and in 23,900 years the eccentricity will have reached its minimum, and become most like a circle, but from that time it will gradually become more eccentric. The mean distance of the earth from the sun is 91,400,000 English miles; the greatest eccentricity of the orbit is about 1-13th of this distance, while the smallest is 1-360th. At the time of its greatest eccentricity the earth would be about 14½ millions of miles further from the sun than when its orbit most nearly approaches a circle. At the present time the difference amounts to 3 millions of miles. We must further bear in mind, that at the present time the earth in the winter of the northern hemisphere is nearest the sun (in perihelion), and in summer it is furthest from it (in aphelion). But even this condition is subject to a periodical change, which runs its course in 21,000 years. In about 10,000 years hence the summer of the northern hemisphere will coincide with the time when the earth is nearest the sun, and the winter with the time when it is furthest from it; while, of course, these conditions will be reversed in the other hemisphere. It has therefore, been assumed that at those periods when the earth has reached its maximum eccentricity, and when it also is nearest to the sun in winter (or in perihelion), this hemisphere has had a shorter and warmer winter, but on the other hand a longer and cooler summer; while the southern hemisphere must at this period have had exactly the reverse, that is a longer and colder winter, and a warmer and shorter summer, because the greatest distance from the sun must coincide with the winter of this hemisphere. Mr. Croll supposes that during this longer and colder winter so much ice must have formed, that the short summer, though certainly warm, would not have been able to melt it, and that the glacial period was a consequence of these conditions. During this period a perpetual spring would have prevailed in the other hemisphere, for the long summer was cooler, and the short winter on the other hand was warmer. The astronomer, Mr. Stones, has calculated that 850,000 years ago the eccentricity of the earth's orbit was at its maximum, and the northern hemisphere had the winter in aphelion. At that time the length of the winter was increased by thirty-six days. Very much ice and snow must have accumulated in this period, and consequently Lyell is inclined to consider this as the Glacial age. On the other hand, 900,000 years ago the eccentricity was at its minimum,and consequently other data must be given for the conditions of climate.

But with respect to all these speculations, we must bear in mind the insufficiency of our knowledge as to the effect which the distance travelled by the sun's rays from the sun to the earth has on their intensity. Lyell has very justly drawn attention to the fact, that, according to the calculations of Dove, the earth is warmer in July, when it is actually further from the sun, than in December, when it is nearest to it. This arises from the different distribution of land and water in the southern and northern hemispheres, so that the latter has a warmer summer than the former, although in the summer the sun is nearer to the south than the north. But even this shows, that the distribution of land and sea on the earth is of much greater importance, in a question of climate, than the greater or smaller eccentricity of the earth's orbit, which ought not therefore to have such an excessive influence ascribed to it. Still, it is an item by no means to be neglected, and one which, combined with varied distributions of land and sea, must exercise a great influence. Sir Chas. Lyell has demonstrated this in a most masterly manner.

A second cosmical agent for changes of climate may be looked for in the sun itself. With respect to the spots on the sun's disc, we know that perpetual changes are going on upon the surface of the sun, so that there is at least a possibility that the action of the sun's rays may not always have been the same.

But, besides the sun, there are also in the universe millions of heavenly bodies, pouring out their lightening and warming rays into the firmament. It is, therefore, possible, that different places in this infinite universe may possess a different temperature, as has been pointed out by the mathematician Poisson, who reminds us that the number of stars is so great that they form, as it were, a continuous covering over us.

Now, we know that the sun, together with its planets, is continually changing its place in the universe; and, probably, together with them, is circling round some one great fixed star at an immeasurable distance. If we consequently venture to suppose that the universe has not everywhere the same temperature, we should have the most simple explanation of the phenomena we have described. If the sun, with its planets, was, in the Miocene times, in a part of the universe possessing a higher temperature than that in which it now moves, this warmth would have been proportionably shared by every part of the earth, and would more especially have had an influence on the temperate and polar zones, and have caused a proportionate increase of temperature. Then, again, in this year of our sun (if it may be so expressed), there would be an alternation of colder with warmer seasons; and the Miocene age may be compared with its summer, the Glacial age with its winter, and our present age with its spring. This orbit of our sun is, indeed, one of immeasurable length, and we cannot yet fully comprehend it. But there is a time coming when its extent will be calculated; and races yet unborn will teach in their hand-books the course of the sun, just as we now do the courses of the planets. If we, as it were, become dizzy with surveying the vast period of ages here spread before us, we ought to consider how small is the measure we are accustomed to apply to it. A glance will show us this. There are many living things whose life is but a day long. Let us imagine for a moment that one of these beings were endowed with consciousness;—or that the life of man lasted but for a day: now, an individual, born in winter, could only learn by tradition that the climate was once warmer, and that at some future time, after a long series of generations, a warmer period would again occur: and another individual, born in summer, could only learn by means of races long since passed away, that this warm weather would be followed by a long cold season, and that afterwards the warmth would again return. One of our years must to these beings of a day have seemed immeasurably long, as it would have included 365 generations.

But the present age of the world is not even a day,—it is hardly a minute of the great orbit, or year of our sun; and no mortal will be able to note its phases. We certainly cannot examine them with our bodily eyes; but we can do so with our mental vision; for, in spirit, we can look back into far gone ages, and recognise the connection of phenomena which have occurred in the course of thousands of years. The mental eye glances into the very earliest periods of time, and scans even the furthest regions of the universe.

But however small man may be corporeally, when compared with the immensity of nature—however short may be his life on the shoreless sea of time; yet, as to his mind, he is great; for it is this which raises him above the vicissitudes of ages, and gives him a consciousness that, under his perishable body, he hides the germ of an endless life.

II.—ON THE DENUDATION OF THE COTTESWOLDS.

By E. WITCHELL, F.G.S.

(Proceedings of the Cotteswold Naturalists' Field-club. 1867.)

THIS paper is a valuable contribution to the advancement of that theory of denudation which seems to be steadily gaining ground, and which explains the formation of present irregularities of surface by the action of subaërial forces. The following are the chief points insisted on:—

There is no evidence that the valleys of the Cotteswolds were cut out by the sea or by tidal rivers: the sea would tend rather to wear away inequalities. There is abundant evidence of denudation, but it is of subaërial denudation, helped by landslips.

It has been held that tides acting along lines of fracture are essential to the formation of the Cotteswold valleys, and it is a fact that there are fractures in many of the valleys; but this is not enough, the existence of the conditions needful for the action of tides along lines of fracture must be shown;—the land must have been low enough for the tides to reach it, and the fractures must have been opened into fissures wide enough to admit large volumes of water, and long enough to account for the formation of the long valleys as they now exist. There is no evidence of these things.

A close connection exists between combes and springs; there are no combes without a spring, and when a combe forks there is a spring in each branch. It may be said that the excavation of combes by the sea would cause springs; but in this case surely some of the combes should be without springs, as one can hardly suppose that the sea would make combes only where subterranean springs abounded. This connection of combes and springs makes it hard to account for the formation of the former except by means of the latter.

The widening of the valleys is owing in great part to slips; but this process is now somewhat checked by the streams having been made more or less artificial, and therefore hindered from carrying away fallen matter. The slips from the Fuller's Earth are very many; there is hardly a combe cut into that formation and the overlying Great Oolite without a slip, sometimes stationary at present, sometimes moving slowly; indeed where Fuller's Earth occurs on an escarpment a great part of the slope is moving. The Inferior Oolite has so tumbled that it is not uncommon to find quarries of the Freestone on the sands below, or on the Upper Lias.

The slopes facing south or south-west are more denuded and less steep than others, because more exposed to rain.

A very large amount of earth is carried away by springs and storm-waters; frost too has a great effect on soft Oolitic rocks.

In going up a valley one finds that the volume of the stream gets less, and so also does the amount of denudation, until the valley is a mere hollow, and at last vanishes. Then, within a few yards, the ground begins to slope in the opposite direction, and gradually takes the form of a valley like the former, but falling the other way.

Sub-angular gravels, which cannot be looked on as marine, but only as subaërial and fluviatile, are found in the valleys at heights ranging from 200 to 700 feet: it is clear therefore that like conditions held during the whole period of the formation of the valleys, and that no such deposits could have taken place in valleys washed by tidal waters.—W. W.

III.—PRELIMINARY NOTICE OF A NEW CRYSTALLINE FORM OF SILICA.—By Professor G. VON RATH.

[Poggendorff's Annalen Band CXXXIII.]

THE two great groups of Silica, the crystalline (Quartz) and the amorphous (Opal), with the respective densities of 2·65 and 2·2—2·3, appear likely to have a third and intermediate species added, which, crystallising in forms belonging to the rhombohedral system, yet possesses the low specific gravity of 2·2—2·3; thus by its crystalline character being related to the species Quartz, and by its low density to the species Opal. The crystals, though belonging to the rhombohedral system, the author states, stand in no relation to any of the hitherto observed forms of Quartz. They are in hexagonal tables, never simple, but always in twins, mostly of three individuals (Drillingen), from which character the author proposes the name Tridymite, and under this name the mineral will be fully described by him in the next part of his "Mineralogische Mittheilungen." The crystals are not pseudomorphous, as has been suggested, as by polarised light they behave as doubly refracting optically uniaxial bodies. The Tridymite is found in small but sharply defined crystals in cavities in a volcanic porphyry, accompanied with iron-glance and acicular crystals of hornblende from the Cerro S. Cristobal, near Pachuca, Mexico. Should the further description tend to substantiate the correctness of Professor von Rath's observations, it is evident that some of the arguments put forward both by the supporters and opponents of the igneous theory of the origin of Quartz in modern volcanic lavas and granite, based on its density, will be materially affected. The fuller particulars will be anxiously looked for. T. D.

REVIEWS.

Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Edited by Prof. T. Rupert Jones, F.G.S. Part V. London: H. Baillière. 4to. Part V. April, 1868.

In this part the description of the Geology of the Vezère is completed by a short account of the ossiferous caves and recesses. These "(whether or not, in some cases, enlarged artificially) have been hollowed out by atmospheric agency, where the softer alternate with the harder bands of limestones, the latter often still forming more or less continuous ledges around the interior."

With regard to the in-filling of the cavern of Le Moustier with red, sandy, micaceous alluvium, very similar to the brick-earth of the valley below, "it is not necessary to suppose that the cave was on a level with the flood-waters of the valley since Man inhabited it; for, as Mr. John Evans has suggested (Geol. Soc. Lond. June 22, 1864), the sand may either have been blown in by the winds, or, possibly, it may have reached the cave from the top of the hill during the formation of a talus, removed for the most part, since that time, by the river having swept the foot of the cliff, from which it has now receded."

Some such explanation as the above is absolutely requisite in cases where the valley is of very considerable width, and the filling in of some of the caves on the east side of Gibraltar, partly by wind-blown sand from Catalan Bay, and in part by a talus formed of disintegrated limestone from the rock above, confirms the correctness of Mr. Evans's suggestion.

In narrow valleys, however, where the river passes between perpendicular limestone cliffs, the rise of the waters during heavy rains, (especially if obstructed by fallen trees and other similar débris) would be extremely rapid, and one can readily conceive that in such cases fine sediment might be washed into caves considerably above *ordinary* high-water-mark.

A gentleman engaged upon the Geological Survey in Australia, mentions an interesting fact in illustration of the difference of level in a country where the rain-fall is considerable. At the time of his writing home he was encamped in a dry gully or watercourse, where, at the height of sixty feet above his head, the wreck of last year's floods was still hanging from the roots and branches, and clinging to the rocky walls of the cliff.

An interesting comparison is instituted between certain of the implements found in the caves of Dordogne, and some now used by the North-American Indians. Much valuable information, and many illustrations (communicated by Mr. Alexander C. Anderson, of Vancouver's Island), are added, which tend to explain the uses of many weapons not heretofore understood. Many suggestions are also offered as to the nomadic habits of the aborigines, their methods of hunting, and general mode of life.

In the last number of the GEOLOGICAL MAGAZINE, for May, p. 599, quoting from M. Gervais' recent work, on the animals found associated with man in Western Europe, "The Epoch of the Domestic Reindeer" is spoken of. We are glad to find so experienced an authority as Mr. Anderson decidedly opposed to this view. He writes, "there is nothing to authorise the supposition that they" (the Germani or the Aquitanians) "*tamed* the Reindeer for domestic purposes, but only hunted it." It seems very doubtful whether they possessed any domesticated animals, save perhaps the dog. That the horse was wild, like the reindeer, and formed an object of the chase and an article of food, is abundantly proved by the numerous remains met with in some of the French caverns, especially in that of Bruniquel. From the bones of the horse many of their best implements (*e.g.* needles) were manufactured.

Much has been said and written of late, in favour of connecting the ancient inhabitants of Gaul with the modern Laps, Fins, and Esquimaux; probably this has arisen from the theory, that the prehistoric people of the south migrated northwards in quest of the herds of reindeer which by reason of a change in the climate, or, the increase of their enemies, ceased to visit central and southern France as in earlier times. A certain similarity in their weapons of the chase and other manufactured articles discovered in their retreats has also favoured this view. But Mr. Anderson justly observes that "Any theory, based upon the disappearance of the Reindeer from southern latitudes, in connexion with the migration northward in remote ages of the past of the Esquimaux and other northern tribes, ought, I submit to be very cautiously entertained." Nor would it be prudent, I think, to found too much upon the similarity of implements now, or recently, in use among divers barbarous nations, and the interesting relics which have been discovered in Dordogne." Mr. Anderson adds his belief "that under similar circumstances and conditions of things, isolated branches of the human race will arrive, in simple matters of domestic or offensive art, at nearly similar conclusions, each independently of the other." In this belief Mr. Anderson is supported by M. Troyon, Dr. Ferdinand Keller, and many other able investigators of pre-historic man in Europe, who have expressed their views in nearly the same words.

The Plates in the present part, which continue to be executed in the same admirable manner, are Plates xv. and xvi., flint flakes, well selected to illustrate varieties of forms. Plate xvii., four cutting or chopping hatchet-like implements of flint, from Le Moustier, similar in type to those of the old gravel of the Somme, etc. Plate xviii. is devoted to the illustration of flint scrapers and awls. The two remaining plates commence a series of "Sketches on the Vezère," the first being a view of Le Moustier, the second of Les Eyzies, near the Junction of the Beune and the Vezère. They are executed by W. Tipping, Esq., F.S.A.

II.—AMERICAN SCIENTIFIC AND POPULAR JOURNALS.

1. SILLIMAN'S AMERICAN JOURNAL OF SCIENCE (2nd Series, No. 130, p. 96) contains an interesting description of the Glaciers of Alaska, Russian America, by Mr. William P. Blake.

"In ascending the Stickeen River" (writes Mr. Blake), "one glacier after another comes into view; all of them upon the right bank of the stream, and descend from the inner slope of the (Blue) mountain range. There are four large glaciers, and several smaller ones visible within a distance of 60 or 70 miles from the mouth. The first glacier observed, fills a rocky gorge of rapid descent, about two miles from the river, and looks like an enormous cascade. The mountains are greatly eroded by it, for it is overhung by freshly-broken cliffs of rock evidently produced by the action of the glacier."

"The second glacier is much larger and has less inclination. It sweeps grandly out into the valley from an opening between high mountains, from a source that is not visible. It ends at the level of the river in an irregular bluff of ice, a mile and a half, to two miles in length, and about 150 feet high. Two or more terminal moraines protect it from the direct action of the stream. What, at first sight, appeared to be a range of ordinary hills along the river, proved, on landing, to be an ancient terminal moraine, crescent-shaped, and covered with a forest. It extends the full length of the front of the glacier." Within this old moraine is a belt of marsh-land and ponds of water, and then commences the modern moraine, which is destitute of vegetation of any kind, and covered with huge blocks of granite, perched in every conceivable position upon the most slender ice-columns, and ready to be hurled down at any moment. The glacier itself seemed rent and torn and faulted by huge chasms and crevasses, filled in some cases with mud and water, in others, higher up, with hard snow. The surface of the glacier was found to be broken up into irregular stair-like blocks with smooth sides, and so large that it was impossible for Mr. Blake's party to ascend them without ladders or tools to cut footholds with. His sketches of the bluffs of the great glacier are very striking, and his paper will form a valuable contribution to the history of glacial phenomena.

In the same number, Mr. C. A. White gives a sketch of the Geology of South-Western Iowa, with a clear and concise summary at the end of the nature and succession of the rocks from the Lower Coal-measures to sandstones, believed to be of Cretaceous age. In No. 132 there is given an account of the "San Louis Park," an immense elliptical basin (in which the Rio Grande del Norte takes its rise), surrounded—save where penetrated by the Poncho and other passes—by the lofty Sierras of the Colorado Mountains.

The Park contains a surface-area of 9,400 square miles, at an average elevation of 6,400 feet above the sea-level. Entirely around the edge of the plain and uniting it with the mountain foot, runs a smooth glacis, resembling a sea-beach. From this glacis rise continuously all round the horizon the great mountains, elevating their heads above the line of perpetual snow. At 5 to 6,000 feet above the plain a level line marks the cessation of vegetation, above which naked granite and snow alone are seen.

The centre of the plain is occupied by the San Louis Lake, sixty miles in length, fed by nineteen confluent streams, but without any outlet to its waters. Its water-surface expands over the Savannah during the melting of the snows upon the Sierras, and contracts when the season of evaporation returns. Seventeen lofty peaks mark the serrated rim of the park, the highest of which has an elevation of 16,000 feet above the sea.

The climate appears to be healthy in the extreme, and subject to but little variation.

The flanks of the mountains are clothed with dense forests of pine, fir, spruce, hemlock, aspen, oak, cedar, pinon, and a variety of smaller fruit-trees and shrubs, interspersed with luxuriant mountain pastures of verdant and nutritious grasses.

The mineral wealth of this region appears to be great, and only needs railway transport to render it equal if not superior to any in America. Already the Park is occupied by a population of 24,000 Mexican-American settlers, and their numbers are augmenting rapidly. The details of the geology of this region will be received with great interest. As many able Americans have already visited and examined it, their reports may be shortly looked for.

In No. 133, Mr. Edward Hungerford contributes a paper on Evidences of Glacial Action on the Green Mountain Summits in Vermont, whose highest elevation is 4,430 feet.

2. In No. 11 of the AMERICAN NATURALIST, Dr. Jeffries Wyman gives an account of some Shell-mounds or Refuse-heaps in the State of Maine. These agree in the most singular manner with the shell-

mounds of Denmark, the Orkneys, Scotland, and Ireland, containing abundant remains of land-animals, and birds, as well as the bones of fishes and the shells of mollusca, together with the rude weapons of stone and bone left by the aborigines, many of which strongly remind us of the weapons brought by our Arctic explorers from the shores of Arctic America, and used by the Esquimaux of to-day.

Dr. C. A. White gives an account of certain lake-like hollows and depressions found in Iowa, supposed to be of artificial origin, some of which are now dry, and some still occupied by sheets of water. They have obtained the name of "walled lakes" from the heaping up of the large boulders along the shore in the direction of the prevailing winds, and the washing away of all the finer portions of the glacial drift in which these lake-basins have been formed. Dr. White shows that the action has continued since the Glacial epoch, and is going on at the present day. He gives an interesting account of the ancient river-terraces, also cut through the glacial drift, which covers a large portion of Iowa.

3. THE CANADIAN NATURALIST AND GEOLOGIST, New Series, Vol. III., No. I., contains a useful comparison of the icebergs of Belle-Isle with the Glaciers of Mont Blanc, with reference to the Boulder-clay of Canada, by Principal Dawson, LL.D., F.R.S., F.G.S. No. 3. On the Geological Formation of Lake Superior, by Mr. Thomas Macfarlane. On a subdivision of the Acadian Carboniferous Limestones, by Mr. C. Fred. Hartt, A.M.

Several of the papers published in this periodical have already been noticed in the pages of the GEOLOGICAL MAGAZINE, and we shall take any early opportunity to notice the others, whenever space permits.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—I. April 8th, 1868.

The following communications were read:—

1. "On the Affinities and probable Habits of the extinct Australian Marsupial, *Thylacoleo carnifex*, Owen." By W. H. Flower, Esq., F.R.S., F.G.S., etc.

Thylacoleo was first described by Prof. Owen in the Philosophical Transactions for 1859, from an imperfect skull, the characters of which led to the conclusion that it was "one of the fellest and most destructive of predatory beasts," having its nearest affinities among existing marsupials with *Dasyurus ursinus*, although the interval be still very great between them. In a subsequent description of a more perfect skull, Prof. Owen's views of the affinities, though not of the habits and food of the animal, were modified. It was stated to be more nearly related to the Diprotodons, Nototheres, Koalas, Phalangers, and Kangaroos, but at the same time to exemplify "the simplest and most effective dental machinery for predatory life and carnivorous diet known in the Mammalian class."

The author of the present paper, while entirely concurring with

Prof. Owen in his later views of the affinities of *Thylacoleo*, and pointing out in detail its relations, especially with the Rat Kangaroos (*Hypsiprymnus*), and the Phalangers (*Phalangista*), demurred to the soundness of the conclusion as to its predaceous habits. He remarked that, as the greater number, if not all, of the known animals of the group to which *Thylacoleo* undoubtedly belongs, are either vegetable or mixed feeders, the probabilities would be that this creature conformed with its congeners in this respect, unless it possessed any such striking adaptive modification of the normal typical dentition of the group as to lead to a directly opposite conclusion.

He then proceeded to discuss this question, showing that in its rodent-like incisors, rudimentary canines, and hypsiprymnoid premolars it presents no sufficient approximation to any of the true predaceous carnivores, either placental or marsupial, as in his opinion to justify the inference as to its habits, which is expressed in the name bestowed upon it.

2. "On the Thickness of the Carboniferous Rocks of the Pendle Range of Hills, Lancashire." By E. Hull, Esq., B.A., F.R.S., F.G.S., of the Geological Survey of Scotland.

This paper was supplementary to a former communication by the author, in which he endeavoured to prove the south-easterly attenuation of the Carboniferous *sedimentary* strata of the North of England, while the *calcareous* member (the Mountain-limestone) attained its greatest vertical development in Derbyshire, and thence thinned away northward and westward. The author now gave the results of his subsequent investigations while engaged in the survey of the Pendle range and the neighbourhood of Burnley and Blackburn, which have shown that the increase in the thickness of the *sedimentary* deposits is continued into that district, the aggregate thickness of the Coal-measures, the Millstone-grit, and the Yoredale series being in the Burnley district 18,635 feet, while in Leicestershire it has dwindled down to 3,100 feet. In discussing the question of the source of these sediments, the author came to the conclusion that they were derived from a primæval Atlantis,—a view which he considered to be strengthened by the fact that the Carboniferous sedimentary strata of North America also swell out towards the north-east, and become attenuated towards the south and west.

3. "Observations on the relative Ages of the leading physical Features and Lines of Elevation of the Carboniferous district of Lancashire and Yorkshire." By E. Hull, Esq., B.A., F.R.S., of the Geological Survey of Scotland.

The author first described the Pendle Range as a great arch of Carboniferous rocks, bordered on the north and south by a succession of parallel (W.S.W. to E.N.E.) arches and troughs, to all of which he assigned a Pre-Permian age. He regarded them as belonging to the earliest of three consecutive periods of disturbance, to which all the principal flexures and faults of the district may be referred. The Pennine Chain, which runs nearly north and south, he believed to have been upheaved during a later period, namely, the close of the Permian, while the numerous north-west faults of the district under consideration he referred to the close of the Jurassic period. Mr. Hull described in detail the evidence upon which these conclusions rested, observing that, immediately upon the close of the Carboniferous period, the northern limits of the Lancashire and Yorkshire coal-fields were determined by the upheaval and denudation of the beds along east and west lines, the coal-fields themselves retaining their original continuity across the region now formed of the Pennine Hills, from Skipton southwards. At the close of the Permian period these coal-fields were dissevered by the uprising of the area now formed of the Pennine range, by lines of upheaval ranging from north to south, nearly at right angles to the former, this fact being of itself an evidence of difference of age. In conclusion the author pointed out that the denudation of the rocks of the district may be referred to seven periods, beginning with the commencement of the Permian and ending with the Post-glacial; he defined the duration and effect of each of these periods, and stated the evidence on which his conclusions rested.

4. "On a Saliferous deposit in St. Domingo. By M. D. Hatch, Esq. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.R.S., F.G.S., etc.

The author described a deposit of salt situated about 15 miles from the harbour of Barabona, and about half-way between it and the great salt lake of Emiquilla.

II. April 22nd, 1868.

The following communications were read:—

1. "On the Disposition of Iron in Variegated Strata." By George Maw, Esq., F.G.S.

The author considered the subject under the following heads:—

1. Literature.
2. The states of Combination of Iron in the principal stratified rocks.
3. The Primary Conditions of Iron in Red beds.
4. The variegation of Red beds due to differences in the amount of colouring oxide.
5. Discolouration and bleaching connected with joints.
6. The variegation of the Keuper Marls.
7. The influence of organic matter in inducing variegation.
8. Variegation due to the decomposition of Bisulphide of Iron.
9. Variegated Cambrian slates.
10. The discolouration of Red beds by lime and magnesia.
11. The ferruginous banding of yellow sandstones.
12. The condition of the Iron in the bleached areas.
13. Exceptional cases of secondary variegation.
14. General summary and conclusions, viz.:—

1st. That the assumed production of the colouring matter of red beds from the decomposition of Iron Pyrites, appears on several grounds untenable.

2nd. With reference to the action of fossil Carbonaceous matter in inducing the bleaching of red beds, the mere reduction of the red peroxide to a lower state of oxide of less colouring power will in none of the cases examined account for the fact of the variegation: an increased *proportion* of protoxide to peroxide in the bleached portions is rarely found, and a material increase in the *amount* of protoxide in the bleached portions never occurrs.

3rd. The bleaching induced by the presence of organic matter, and nearly every form of variegation of red beds, consists in the actual passage of the oxide of iron from the discoloured areas, unaccompanied by any change of combination, excepting the invariable conversion of the anhydrous into the hydrated peroxide.

4th. The re-arrangement of the iron in variegated beds is not through the agency of dissolution, for it is more frequent in beds coloured with the insoluble peroxide, than where the iron occurs as the more soluble protoxide.

5th. The dispersion of the peroxide of iron has been in some cases incited under a variety of evident conditions independent of mere chemical reaction, and in other cases precisely similar changes of position of the colouring oxide seem to have taken place arbitrarily, unconnected with any apparent cause or condition; and again, in some cases the fresh location of the moved peroxide of iron is evident, whilst in others the disposal of the iron removed from the bleached areas is difficult to account for.

6th. This rearrangement of the colouring peroxide of iron is rarely accompanied by any other change of position or state of combination of the other constituents of the stratum, and appears to be wholly independent of its chemical constitution; in short, the movement of the iron seems to be inexplicable on any simple chemical theory.

7th. The motion has sometimes taken place centripetally, the peroxide being aggregated to a nucleus forming the centre of the area of discolouration, and sometimes centrifugally as a ring of redeposited peroxide around the bleached patch.

8th. Of the forms of variegation due to simple chemical change, unaccompanied by any movement of the iron, the most frequent is the partial conversion of the Carbonate of protoxide into the hydrated peroxide, and also of the red anhydrous into the yellow hydrated peroxide, and less commonly the secondary formation of the bisulphide; also the several stages of decomposition of the bisulphide occurring in mechanical association with the peroxide, in various strata; and lastly, the infiltration of lime and magnesia into red beds.

9th. Some of the more complicated forms of variegation of red beds appear to be the joint result of the phenomena of segregation, and changes of combination which may have proceeded simultaneously or in succession.

10th. The ferruginous banding of yellow sandstones appears to be the result of the segregation of the hydrous peroxide of iron into lines which are invariably adjacent to a bleached part of the stratum over which they have advanced, gathering up the peroxide of iron in their course, and leaving behind them an exhausted area; this motion has sometimes taken place in the plain of stratification. Occasionally centrifugally advancing from a depleted area, more frequently centripetally towards a nucleus which it ultimately environs with a ferruginous crust.

11th. The bleaching of the Cambrian slates is due to two distinct causes, viz., (*a*) the occurrence of light bands adjacent to interbedded dark green layers, to the actual departure of the greater part of the colouring oxide without any increase in the proportion of protoxide to peroxide, and appears analogous to the local bleaching of red beds. (*b*) The conversion of blue and purple slate to green in large fields of colour by the conversion of most of the peroxide of iron to protoxide, and to which the green discolouration adjacent to the dykes of intrusive diabase is analogous.

2. "On the older Rocks of South Devon and East Cornwall." By Harvey B. Holl, M.D., F.G.S.

The author divided the rocks of the district to which the communication referred into a Lower, Middle, and Upper South Devon Group, and stated that the lowest beds were brought up along a line of country extending from Dartmoor by Hingston Down to the Brown Willey granite, where they formed a broad anticlinal axis. These rocks are unfossiliferous, and may not be lower in the series than the base of the Ilfracombe group of North Devon, or the highest part of the group immediately below it, the latter being more probably represented by some still lower beds of red and greenish grits brought up to the surface in the anticlinal axis of St. Breock's Down further to the west.

The Middle South Devon Group comprises at its base the discontinuous calcareous range of the Looe River, St. Germans, Brickfortleigh, Ashburton, and Bickerton, above which is a mass of blue and claret-coloured slates, which separates it from the upper or Plymouth and Torbay Range.

This calcareous and fossiliferous group is succeeded by higher beds of blue and claret-coloured argillaceous slates, followed by hard, red, micaceous schists, and purple and greenish grits, which constitute the author's Upper South Devon Group. These rocks are very sparingly fossiliferous, and probably correspond to the upper and Morthoe portions of the Ilfracombe series of North Devon.

The uncomformable position of the Culm-measures is seen in the circumstance that they rest upon different parts of the underlying Devonian rocks; sometimes on the limestones of the Torbay Range, sometimes on the slates, at others on the volcanic rocks. This unconformability entirely separates the older rocks of South Devon from the Carboniferous System.

The occurrence of the genus *Pteraspis* and probably *Cephalaspis*, with *Phyllolepis concentricus* and (?) *Holoptychius*, and other fish-remains, appeared to the author to go a good way towards identifying these Cornish and South Devon beds with the Old Red Sandstone of Scotland. These fossils range up to the very base of the Torbay limestones.

The author referred the whole of the rocks treated of, with the exception of the purple and greenish grits of St. Breock's Down to the Middle Devonian System, and considered that if the lower or Linton rocks were to be met with at all on the south side of the Culm-trough, it would be in the high ground which forms the watershed of West Cornwall.

In the concluding portion of the paper, Dr. Holl entered upon the palæontological relations of the different South Devon Groups, and especially those of the Petherwin beds.

GEOLOGICAL SOCIETY OF GLASGOW, April 2nd, 1868.—The following papers were read:—

I. "On the Post-Tertiary Beds of Scotland." By the Rev. Henry W. Crosskey and Mr. David Robertson.

This paper dwelt upon the necessity of a classification of the Post-Tertiary beds, both on physical grounds and with reference to their fossil contents. Five distinct classes of Post-Tertiary beds were indicated. (1) Clays indicating the extreme range of cold, and with the most intensely Arctic fauna. Among these may be placed the beds at Errol, Dalmuir, Paisley, Stevenston, Lochglip, Kilchattan, and others. At a new bed lately investigated, near Millport, the plates of an Echinus, new to science, have been found. The authors obtained the same plates from some old beds in Norway, but are not aware of its occurrence in any other localities. (2) Clays indicating a moderate depth of water, and largely Arctic, but not so intensely northern as the preceding. Many of these clays crop out at half tide at numerous places in the Frith of Clyde, and the upper parts of many of the clay-pits, which have, in their lower parts, the most arctic fauna, may be ranked in this class. (3) Clays and sands denoting an increase of warmth, which continued until, very possibly, even a higher temperature than at present prevails, was reached. A typical bed of this class occurs in the Kyles of Bute. (4) Clays and sands in which the fauna approaches very nearly to that now prevalent—the only difference being in the proportion of various species. Examples of this class may be seen in the lower part of the section at Irvine Water and the *Ostrea* bed near the Bridge of Allan. (5) The more recent raised beaches—common along the whole coast. It is most important that a complete list of species should be drawn up for every separate locality, and the authors propose to insert some special catalogues they have prepared, in the next part of the Transactions of the Society.

II. "On the Surface Geology of the District round Glasgow, as indicated by the Journals of certain Bores." By Mr. James Bennie. —The object of this paper was to communicate the results obtained by the study of the surface portions of certain bores lately made for minerals, in order that the attention of geologists might be directed to this mode of research, as capable of supplementing natural sections, which are often imperfect from not exhausting the surface deposits; and also in directing inquiry into interesting localities, which, from the surface being flat, nothing could be known except by direct boring.

The journals of bores referred to had been collected exclusively by Mr. James Croll, during the latter part of last summer, before leaving for Edinburgh to join the staff of the Geological Survey of Scotland. These might be arranged into three divisions. First,—those bores which prove that breaks occurred in the formation of the Boulder clay, during which great beds of such water-formed materials as sand, gravel, or mud were laid down upon true ice-made *debris* alternately several times in succession, showing thereby that the glacial epoch was not uniform in character or duration, but was broken by comparatively warm periods, during which water instead of ice determined the character of the deposits. Some of the facts which proved this were very remarkable. One bore at Larkhall had in section—brown till, 8 feet; sand, gravel, and mud, 36 feet; brown till and boulders, 17 feet; sand, 3½ feet; brown till and boulders, 26 feet; mud and sand, 31 feet; brown till and boulders, 6 feet; from which it is evident that the water periods were not short, when 36 feet in the first, and 31 feet in the third were deposited during their continuance. Another bore in the Mains of Garscadden gives—first, boulder clay, 78 feet; then follow various beds of sands, gravels, and clays, 127 feet; then succeed enough of Boulder-clay at the bottom to give an inter-glacial character to the 127 feet of aqueous sediment resting upon it. Another bore, in the farm of Millichen, gives a greater variety. In it there are, first—brown clay and stones, assumed to be Boulder-clay, 17 feet; various beds of mud, sand, and gravel, 150 feet; brown clay aud stones, 30 feet; gravel and sand, 6 feet; a thin bed of Boulder-clay, 6½ feet; another great water period, represented by 66 feet of sandy mud, and then at bottom Boulder-clay, 82 feet;—in all, 355 feet, which is certainly a remarkable group of deposits. Another bore sunk close to West Millichen farm house is 200 feet in depth, and consists of five beds of Boulder-clay interlaced with four beds of sand, one of which is 45 and another 53 feet in thickness. Upon the evidence furnished by these bores, the inference might be justly drawn, that the glacial epoch was not uniformly glacial throughout, but was broken up by warmer periods, during which the ice became water, and instead of Boulder-clay, the undoubted *debris* of ice, sand, gravel, and mud, the forms which water-made drift assumes, was the only sediment possible.

The next division of bores reveal the existence of a deep trough or hollow, stretching from the valley of the Clyde, near Bowling, through Garscadden, the Haughs of Balmore, the valley of Kelvin, and round by the south-eastern end of the Campsie hills, into the valley of the Forth, by Falkirk. The first indication of its existence is very curious. At Duntocher, the surface sand was cut into by the workings of a pit, belonging to Mr. Dunn, at a depth of 306 feet, whereupon the sand rushed into the pit with such rapidity that the miners with the greatest difficulty escaped with their lives. This proves that the surface strata at Duntocher is 306 feet deep. The next intimation of its existence is from a bore made by Messrs. Merry and Cunninghame, on the farm of Drumry, half-a-mile west of Garscadden House. It is 298 feet in depth; 264 feet consist of sand, gravel, and mud, with 33 feet of Boulder-clay at the bottom. As the surface of the ground at Drumry is 68 feet above the sea level, and the depth of the bore 298 feet, consequently if the surface deposits were all removed, the sea would stand at Drumry 230 feet in depth. The knoll upon which Garscadden House is built rises 78 feet above this bore. It is probable, therefore, that the surface deposits under the house are 376 feet in depth. The next bore in the line of this great hollow is that at the Mains of Garscadden, 219 feet in depth, from the details of which it is probable that this hollow had an existence early in the glacial epoch. The next deep bore in its course is at New Kilpatrick, 222 feet, most of which was sand and gravel. Near Kilmardinny House a bore was driven to the depth of 240 feet without reaching the rock. The next is the deep bore at Millichen. As the top of the bore is 134 feet above sea level, and the bore itself 355 feet in depth, this gives 221 feet as the actual depth of the bottom of this hollow below sea level. The only height in the neighbourhood of which we are certain is where the Roman wall crosses the road at 214 feet above sea level, which consequently gives 435 feet as the probable depth of the surface-deposits under the Roman wall. So we may be certain that the Roman navvies who dug the ditch which now forms the only remains of the wall, were in no danger of touching the rock-head in their excavation, and that the supply of raw material for earthworks was here inexhaustible. The next bore is that at West Millichen already detailed, 200 feet, and the last definite bore — the remaining bores being imperfect from not exhausting the surface, or unsuitable from not being driven where the hollow is deepest. The following are their situations and depths:—Summerston, 150 feet, without reaching the rock; Buchley, 127 feet; Torrance of Campsie, 108 feet; Springfield, near Kirkintilloch, 212 feet, but only 111 feet is certain surface; Inchbreck, 110 feet; Auchenreoch House, 62 feet; Gavell, 72 feet; Dumbreck, 120 feet, without reaching the rock, but another bore near the same place reached it at 72 feet; Dennyloanhead, 92 feet; Larbert Junction, 120 feet; Camelon, near Falkirk, 104 feet; and, finally, at Skinflats, within a mile of Grangemouth, a bore was driven through the estuarine mud to a depth of 240 feet, without reaching the rock. As the surface of the ground at Skinflats is only 17 feet above sea-level, the surface deposits must be more than 223 feet below sea-level. Such is the strange fact which these bores reveal—a great, deep hollow, fairly splitting Scotland in twain.

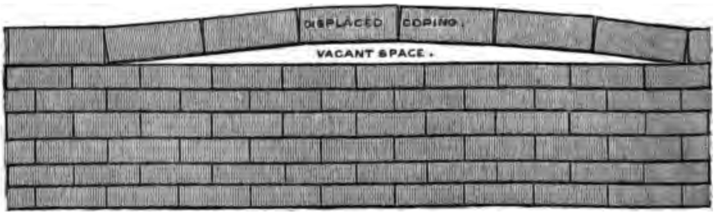
The third series of bores indicate the depth and character of the bottom of that branch of the glacial sea which extended from Paisley over to Garscadden, a distance of fully five miles, in which space more than 50 bores demonstrate the geography of the glacial sea-bottom more effectively than if an Admiralty survey of it had been taken when it was yet recent, and the water in it. It is shown to have been very uneven, as much marked by heights and hollows as any boulder-hillocked region on dry land. Nine of these bores, one at Candren, two at Walkingshaw, five at Blythswood, and one in the bed of the Clyde at North Barr House, went through Boulder-clay alone, by which we learn that, as the ground is flat, they were sunk in what are now subterranean hillocks, but which were once submarine islands or shoals in a sea, depositing mud around them. Seventeen bores—two at Candren, nine at Walkingshaw, one at Blythswood, three at the Barns of Clyde, and one at Blairdardie, went through sand and mud only, the silt of the glacial sea filling up the hollows between the submerged hillocks or shoals. The deepest of these bores are at Walkingshaw, one being 152 and another 159 feet deep; and one, at Shiels, above Renfrew, 144 feet deep, and the remainder from 80 to 100 feet deep. Nineteen bores have more or less Boulder-clay, sometimes only a few feet, at other times more than half. At Craigielee, near Paisley, and Garnieland, near Renfrew, rocks come above ground, and these must have been sunken rocks at that time, against which, doubtless, many an ice-berg struck. From these facts it is clear that the bottom of the glacial sea was extremely undulating, as much so as any modern land surface. Into the hollows of the mud of the glacial sea the washings of these very hillocks were deposited, and in them lived the boreal shells which have made this region so famous in Post-Tertiary geology. J. A.

CORRESPONDENCE.

I.—HORIZONTAL PRESSURE AND VERTICAL DISPLACEMENT.

Sir,—In the March number of the Magazine I made a few observations on the probable connection between the vertical force of gravitation in a sphere with the horizontal force that appears to have produced slaty cleavage.

The converse of this proposition is well illustrated in the distortion of an old brick wall at Shiffnal, in this county, represented in the accompanying engraving, in which the coping has risen from its vertical support and ranged itself into an arch, leaving a vacant space underneath. The mortar joints had evidently been expanded by frost, the length of the coping thereby increased, and the expansion being horizontally resisted, the increased length was compelled to expand itself as a curve.


DISPLACED COPING.
VACANT SPACE.

The case seems strictly analogous to what might take place in the crust of the earth, and seems to bear out the views of the late D. Sharp, on the direction of slaty cleavage.

The applicability of this illustration was first suggested to me in a note from the Rev. O. Fisher, referring to my recent letter in the Magazine, on "Gravitation and Horizontal Compression," in which he observes, "I find that if you take into consideration a spherical shell, of moderate, say a few miles, thickness, and conceive it for a moment unsupported by the matter within, then the horizontal pressure upon any two sides of a cubical element of this shell will be equal to the weight of a column of rock of the same density and half the length of the earth's radius. This would be sufficient to crush any strata, and is, I believe, the force to which the elevation of mountains is due."

If you also take into consideration the effects of even the slightest inequality of local horizontal expansion, due to heat, its resolution vertically, in an arched form (bulging), would account for the fullest amount of displacement observed in the earth's crust. Take a segment of, say, only a hundred miles; an expansion of but $\frac{1}{1000}$ part of its length would produce a vertical elevation of several hundred feet at its centre.

The late D. Sharp's observations (Quart. Journ. of the Geol. Soc., vol. iii., p. 74,) tend to show the relation between the dip of slaty cleavage to areas of elevation in its apparent radiation from the axis of upheaval. If the slightest abnormal expansion is superadded to the uniform horizontal pressure within a sphere due to gravitation, it appears probable that the direction of the force would determine the dip and direction of cleavage plains.

As Mr. Fisher informs me he has recently communicated a paper on a kindred subject to the Cambridge Philosophical Society, I forbear, till it appears in print, to do more than give the drawing of the displaced wall-coping in further illustration of the suggestion I threw out in the March number of the Magazine. GEORGE MAW.

BENTHALL HALL, BROSELEY.
May 2nd, 1868.

FOSSIL PALM-LEAF FROM THE EOCENE OF THE ISLE OF WIGHT.

SIR,—In Room I., Wall-case 6, of the Geological Gallery of the British Museum is a fossil Palm-leaf in a nodule to which the following label is attached:—"*Flabellaria lamanonis*, Brogn. Eocene, Isle of Wight. From Dr. Mantell's Coll^{n}· fig^{d}· at p. 52 of Mantell's fossils of the Brit. Mus. 1851." The locality given in Dr. Mantell's book is White Cliff Bay. On the back of the specimen is written in pencil "Upper Bembridge or Lower Hempstead."

Can any of your readers state the exact locality and bed from which this specimen came, and whether any other specimens have been found in White Cliff Bay?

May 14, 1868. W. STEPHEN MITCHELL.

FISH REMAINS IN THE LOWER DEVONIAN OF SOUTH DEVON AND CORNWALL.

SIR,—I have read with much interest the communication of the Rev. E. Wyatt-Edgell in the GEOLOGICAL MAGAZINE on a Pteraspidian plate found by his son the late Lieut. Wyatt-Edgell, at Mudstone Bay, South Devon.

As I was the person who detected the Pteraspidian plates in the cabinet of Mr. Pengelly, at Torquay, and sent them by my friend Mr. Leonard Lyell, for examination by Prof. Huxley, perhaps I may be allowed to say that several years ago the icthyic character of these fossils was detected by Mr. Pengelly, who only laid the specimens aside, as supposed sponges, on the authority of Prof. McCoy. I beg leave, Sir, therefore to suggest that the Devonian Pteraspis discovered years ago by Mr. Pengelly be named after that gentleman, who has done so much for Devonian geology, and who but for McCoy's mistake would have long ago made known the existence of a Lower Old Red fish in the Lower Devonian seas.

W. S. SYMONDS.

PENDOCK RECTORY, TEWKESBURY,
12 *May*, 1868.

NOTE.—Much as one would wish to see the new Pteraspidian fish-plate from Devon named after Mr. Pengelly, the discoverer, yet, according to the laws of nomenclature, we are bound to retain for it the older of the two names by which it is already known. It must, we fear, remain as *Pteraspis* (or *Scaphaspis*) *Cornubicus*, McCoy, sp. (See GEOL. MAG. for May, p. 248). I believe, more than twenty years ago, that veteran geologist, Mr. Peach, announced the discovery of fish-remains in Cornwall, in the Trans. Royal Geological Society of Cornwall, being the identical fossil afterwards called a Sponge (*steganodictyum*) by McCoy, and now once more pronounced a Fish by Prof. Huxley.—EDIT.

REMAINS OF THE GIGANTIC IRISH DEER *CERVUS MEGACEROS*.—Our correspondent, Mr. G. Henry Kinahan, M.R.I.A., etc., of the Geological Survey of Ireland, kindly writes to informs us that he has just heard from Mr. William Heneby (carpenter), Thomond Gate, Limerick, who has obtained a skeleton of the great Irish deer (*Cervus megaceros*), of which he is desirous to dispose to some Museum.

Mr. Kinahan has recommended this collector to various persons, and he always appears to have given satisfaction. A good skeleton of *Cervus megaceros* is a prize not to be lost sight of.—EDIT.

THE

GEOLOGICAL MAGAZINE.

No. XLIX.—JULY, 1868.

ORIGINAL ARTICLES.

I.—On the Influence of the Gulf Stream.

THE last number of the Geological Magazine contained a translation (by Mr. J. E. Lee, F.S.A., F.G.S., of Caerleon) of two lectures by Dr. Oswald Heer, "On the Miocene Flora of the Polar Regions," in which the author gives the results of his investigation of the fossil plant-remains from the Tertiary deposits of the north of Canada, Banksland, North Greenland, Iceland, and Spitzbergen. His examination has led him to conclude that, amongst them, there were nine large plants of the fern tribe, 78 kinds of trees, and 50 shrubs. Among these, the remains of the beech and the chestnut, like those of our own island, the silver fir, spruce fir, and Scotch fir, the white pine of Canada, the *Sequoia* of California, the cypress and *Salisburia* of Japan, the oak of temperate N. America, the poplar, plane-tree, birch, tulip-tree, the walnut, lime-tree, and magnolia have left their remains where they had grown, attesting a once temperate climate in Tertiary times, where now fields of snow and ice (once believed to be eternal) cover the length and breadth of the land.

Dr. Heer's researches have been carefully considered by the late President of the Geological Society of London (Warington W. Smyth, Esq., M.A., F.R.S.), in his anniversary address (21st Feby., 1868), from which we extract the following:—

"In endeavouring to find an explanation for these facts now placed so distinctly before us, Professor Heer has examined a long series of the hypotheses which have from time to time been advanced. He declines to admit, for a moment, any supposition of the displacement of the poles, and objects to the older views as well as to the recently propounded theory of Mr. J. Evans, F.R.S., which seeks to show that modifications of portions of the earth's crust may be attended by an actual movement of that rigid envelope over its internal nucleus.[1]

"Far more important, in the opinion of the Swiss botanist, is the speculation so admirably reasoned out by Sir Charles Lyell, on the climatal changes which must be produced by a new distribution of sea and land. And yet, granting the most favourable circumstances, and assuming that, instead of the present irregular and unequal distribution of sea and land, we had the continents united near the equator, and only scattered islets left amid great oceans in the higher latitudes, the mean annual temperature would undoubtedly be raised in no small degree, but not sufficiently to admit of the growth of a rich vegetation between the parallels of 70 and 80 degrees. The very fact, however, of the wide distribution of this luxuriant Miocene flora shows that a large area of land was then amassed in the temperate and polar zones, and consequently that such explanation is inadequate to account for the facts.

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[1] For abstract see Geol. Mag. 1866, Vol. III. p. 171.

"Professor Heer, like many others, is much tempted by the ingenious inquiries of Mr. James Croll, on the results of the varying eccentricity of the earth's elliptical orbit. The present tendency of its course is towards the form of a circle, and in 23,912 years it will have made its nearest approximation to that figure, and the excentricity will be at its minimum, or little above half-a-million of miles. At the present time the linear value of the eccentricity is three millions, and when the orbit attains to the opposite extreme of form, it is above fourteen millions of miles. At present, also, the earth is nearest to the sun during the winter of our Northern hemisphere, and furthest during our summer. But since, in the meanwhile, the relative position of the line of the apsides and that of the solstices is affected by a movement of revolution occupying 21,000 years for its completion, our northern summer will, in about 10,000 years, coincide with the perihelion, and the winter with the aphelion. Now when this latter coincidence takes place at the time of maximum excentricity of the orbit, the hemisphere so affected must suffer an unusually high degree of cold; the moisture in winter would be precipitated as snow, and vast masses would be accumulated which the summer's heat would be unable to melt.

"The other hemisphere would in the meanwhile enjoy a temperate climate, like a continual spring. It has been calculated that such a concurrence of these elements of position took place 850,000 years ago, giving thirty-six days of winter in excess, a mean temperature in the latitude of London of 126° F. for the hottest, and 7° for the coldest month, and when it appears probable that the Glacial period was in force, although only 50,000 years earlier, when the excentricity was at a minimum, the climatal conditions must have been entirely reversed.

"Whilst, however, Professor Heer leans to the opinion that some effect from these latter causes may have combined with that of geographical distribution of land and sea to produce changes of climate, and that the latter is probably the more energetic, as it is also the most securely deduced source of action, he looks further for assistance, and suggests the passage of our solar system through regions of varying temperature. This hypothesis was examined in detail by Hopkins, in his admirable paper on the causes which may have produced changes in the earth's superficial temperature, more particularly with reference to its being assigned as an explanation

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[1] For a full discussion of the causes of vicissitudes of climates, *vide* Lyell's "Principles," 10th edit. chap. xii. and xiii.

of the cold of the Glacial period, for which he proves it to be entirely insufficient. Mr. Hopkins showed at the same time, that more might be said in favour of a maximum than of a minimum temperature acquired in this way, but yet that, if our sun were to approach a star within the distance of the planet Neptune, a case incompatible with the continued existence of the solar system in its present form, the stellar radiation would not send to the earth much more than a thousandth part of the heat which she derives from the sun. The inappreciable increase of temperature derivable from this source renders the hypothesis untenable so long as his reasoning remains unimpugned.

"In order to estimate fairly the changes which may have taken place, we must consider the several conditions on which the climate of a given locality is dependent, viz, :—

1. Its altitude above the sea-level.
2. Its geographical latitude.
3. Its distribution of land- and sea-surfaces.
4. Hygrometric condition of atmosphere, cloud-formation and rainfall.
5. The currents of the air and sea.
6. The internal heat of the globe.

The effect of the latter, being at present valued at only $\frac{1}{\ }$° C., may be neglected in questions relating to recent periods, although it must, in all probability, have formed an important item at the time of the more remote geological events."

The distribution of land- and sea-surfaces—the hygrometric condition of the atmosphere, cloud formation, and rainfall—and the currents of the sea and air, have such an immediate and intimate connexion with one another that they cannot be treated separately; and their important influence upon the Flora of the Polar regions deserves to be specially noticed—the more so, as they have been considered by Dr. Heer as *inadequate* to account for so widely distributed a flora in Miocene times.

From our knowledge of Tertiary Plant-beds in other parts of the world, and of the extremely limited areas which they cover, as compared with the associated marine deposits (the Carboniferous period alone excepted), it seems unnecessary to demand for the Miocene Arctic Flora a large and continuous land-surface, or to assume that the whole Polar region enjoyed a luxuriant Flora *at the same time* in precisely similar latitudes. On the contrary, we have every reason to assume the reverse to have been the case.

Take, for example, two parallels of latitude at the present day. Mr. J. F. Campbell (author of "Frost and Fire") writes July 30, 1864, "Off Little Belle-isle, air 48°, water 40°; icebergs in sight when the temperature was taken, wind south. Passed near a small berg which rose 40 feet out of water. It must have been 400 feet thick and 200 long. Passed many others of far larger size; some were guessed at 200 feet high, and were certainly 150 feet above water."[1] This is in the same latitude as London!

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[1] A Short American Tramp, p. 66.

Mr. Redfield[1] states, that in 1831 the harbour of St. John's, Newfoundland, was closed with ice as late as the month of June; yet who ever heard of the port of Liverpool, on our side, though 2° farther north, being closed with ice, even in the depth of Winter? (Maury.)

Again, in Baffin's Bay, on the west coast of Greenland, the glaciers stretch out from the shore, and furnish repeated crops of mountainous masses of ice which float off into the ocean.[2] The number and dimensions of these bergs is prodigious. Captain Sir John Ross saw several of them together in Baffin's Bay *aground in water* 1,500 *feet deep!* Many of them are driven down into Hudson's Bay, and accumulating there, diffuse excessive cold over the neighbouring continent; so that Captain Franklin reports, that at the mouth of Hayes' River, which lies in the same latitude as the north of Prussia or the south of Scotland, ice is found everywhere in digging wells, in summer, at the depth of four feet![3]

How comes it that there is this great disparity in the relative temperature of places lying in the same parallels of latitude? The explanation is to be found in the prevalence of certain winds and oceanic currents, which cause the isothermal line of 32° F. to vary as much as 14° of latitude in passing from east to west, as shown by Professor Dove.[4]

By far the most important of oceanic currents to us is the Gulf Stream. It is, says Captain Maury,[5] "a river in the ocean: in the severest droughts it never fails, and in the mightiest floods it never overflows; its banks and its bottom are of cold water, while its current is of warm; it takes its rise in the Gulf of Mexico, and empties into Arctic seas. There is in the world no other such majestic flow of waters. Its current is more rapid than the Mississippi or the Amazon, and its volume more than a thousand times greater. Its waters, as far out from the Gulf as the Carolina coasts, are of indigo blue. They are so distinctly marked that their line of juncture with the common sea-water may be traced by the eye. Often one half of the vessel may be perceived floating in Gulf-stream-water while the other half is in common water of the sea,—so sharp is the line, and such the want of affinity between those waters, and such, too, the reluctance, so to speak, on the part of those of the Gulf-stream to mingle with the littoral waters of the sea."

This stream is about 25 miles in breadth off Cape Florida, whence its width increases to 127 miles off Sandy Hook, whilst its depth diminishes from 1000 feet to 200 and under as it proceeds northwards.

From the American coast and the banks of Newfoundland it is diverted across the Atlantic, reaching the Azores in about 78 days, after flowing nearly 3000 geographical miles. Our own islands enjoy its warmth, and many a *Spirula* and *Ianthina* is cast by its waters on our western shores.

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[1] Silliman's American Journal of Science, vol. xiv. p. 293.
[2] Scoresby's Arctic Regions, vol. i., p. 208.
[3] Lyell's Principles, 10th edition, vol. i., chap. xii., p. 245.
[4] Lyell's Principles, vol. i., p. 239.
[5] Physical Geography and Meteorology of the Sea, 8th edition, 1860, p. 23.

Scoresby observed its influence in Spitzbergen, in the 79° of N. latitude, the Glaciers being all stopped abruptly on their descent to the sea by the remnant of heat which the ocean still derives from this source; whilst Dr. Petermann has shown that the stream extends *beyond* Spitzbergen along the coast of Siberia to an open sea near the pole.[1]

Mr. Croll[2] has estimated the total quantity of water conveyed by the Gulf-stream to be equal to that of a stream 50 miles broad and 1,000 feet in depth, flowing at the rate of four miles an hour, with a mean temperature of 65°.[3] Before it returns from its northern journey he concludes it has cooled down at least 25°. Each cubic foot of water, therefore, has carried from the tropics upwards of 1,500 units of heat, or 1,158,000 foot-pounds. According to the above estimate of the size and velocity of the stream, 5,575,680,000,000 cubic feet of water are conveyed from the Gulf per hour, or 133,816,320,000,000 cubic feet per day.

Capt. Maury's and Sir John Herschel's estimates are still greater than Mr. Croll's, the calculation of the former giving 6,166,700,000,000 cubic feet per hour, and the latter 7,359,900,000,000 cubic feet per hour. Sir John Herschel estimates the temperature at 86° F.

Principal J. D. Forbes has calculated that the quantity of heat thrown into the Atlantic Ocean by the Gulf-stream on a winter's day would raise the temperature of the atmosphere which rests on France and Great Britain from the freezing point to summer's heat.[4] Mr. Croll has calculated the heat received by the earth from the sun at the equator at the time of the equinoxes as equal to 1,780,474 foot-pounds per square foot of surface daily, and per square mile 40,636,750,000,000 foot-pounds daily. But this represents only $\frac{1}{3121870}$ part of the quantity of heat daily conveyed from the tropics by the Gulf-stream.

At the very time the Gulf-stream is rushing in greatest volume through the Straits of Florida, and hastening to the north, there is a cold stream from Baffin's Bay, Labrador, and the coasts of the north, running to the south with equal velocity. This current is ever flowing inshore on the North American sea-board, and *beneath* the Gulf-stream, but does not mingle with its waters.

It will be sufficient to remind our readers that the great cause of these currents is identical with that which produces the atmospheric circulation, and that it exercises an important modifying influence in each case. The currents of the waters of the ocean, however, cannot travel with the same freedom as those of the air, being constantly affected by land-barriers, which deflect or impede their course. To the diurnal rotation of our earth is attributed the great equatorial current, which traverses the Pacific in a vast stream nearly 3,500 miles broad. Amongst the Asiatic Islands it is broken up, and a part turns to the north-east, supplying the Aleutian Islanders with timber drifted from China and Japan, while the main stream passes on through the Indian Ocean, and finally round the Cape, and runs northward into the Atlantic. This current travels at a mean rate of ten or eleven miles in twenty-four hours; but when forced through narrow channels it acquires a much greater velocity.[1]

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[1] Lyell Principles, p. 215.

[2] Trans. Geol. Soc., Glasgow, vol. ii. p. 177.

[3] Lyell gives the temperature on the authority of Prof. Bache as 80°.

[4] Travels in Norway, p. 202.

Passing inside the Lagullas bank, the current is continued along the western coast of Africa in a northerly course until deflected by the Guinea coast, when it strikes across the Atlantic, impinging on the coast of South America, south of the Amazons, with whose waters it unites, and flowing on into the Carribean Sea, it receives a vast acceleration of temperature, and again departs on a mission to the north as our Gulf-stream.

To us the Gulf-stream must always be an object of extreme interest. It brings us genial showers, borne by the south-westerly winds from the surface of its warm and steaming waters. It carries the temperature of summer, even in the dead of winter, as far north as the Grand Banks of Newfoundland, and there maintains it in the midst of the severest frosts. It is the presence of this warm water and a cold atmosphere in juxtaposition which gives rise to the "silver-fogs" of Newfoundland, one of the most beautiful phenomena to be seen anywhere among the treasures of the Frost-King. Every west wind that blows crosses this stream on its way to Europe, and carries with it a portion of this heat to temper there the northern winds of winter.[2] It is the influence of this stream upon the climate that makes Erin the "Emerald Isle of the Sea"—that clothes the shores of Albion in evergreen robes, and encourages the Myrtle and the Magnolia to flourish at Mount Edgcombe in the open air all the year—which carries West Indian seeds to the Scottish isles, wafts the floating pteropods of the tropics to the latitude of Iceland, and renders the fauna of Spitzbergen richer than any other Arctic realm. To the Gulf-stream we owe our greatness as a nation, and that superiority of climate of which we have just spoken; for if the barrier of Panama were submerged, as it has been at a comparatively late geological time, the equatorial currents would flow on to the Pacific, and the climate of England would become like that of Newfoundland or Labrador,—if not colder.[3]

Nor is it merely with regard to their influence on the climate of the Arctic and Ant-arctic regions that the equatorial current and the Gulf-stream deserve our consideration; for they must in all ages have mainly influenced the migration of marine animals, and in no small degree assisted in the distribution of land plants and animals, probably playing an important part even in the dispersion of man himself.

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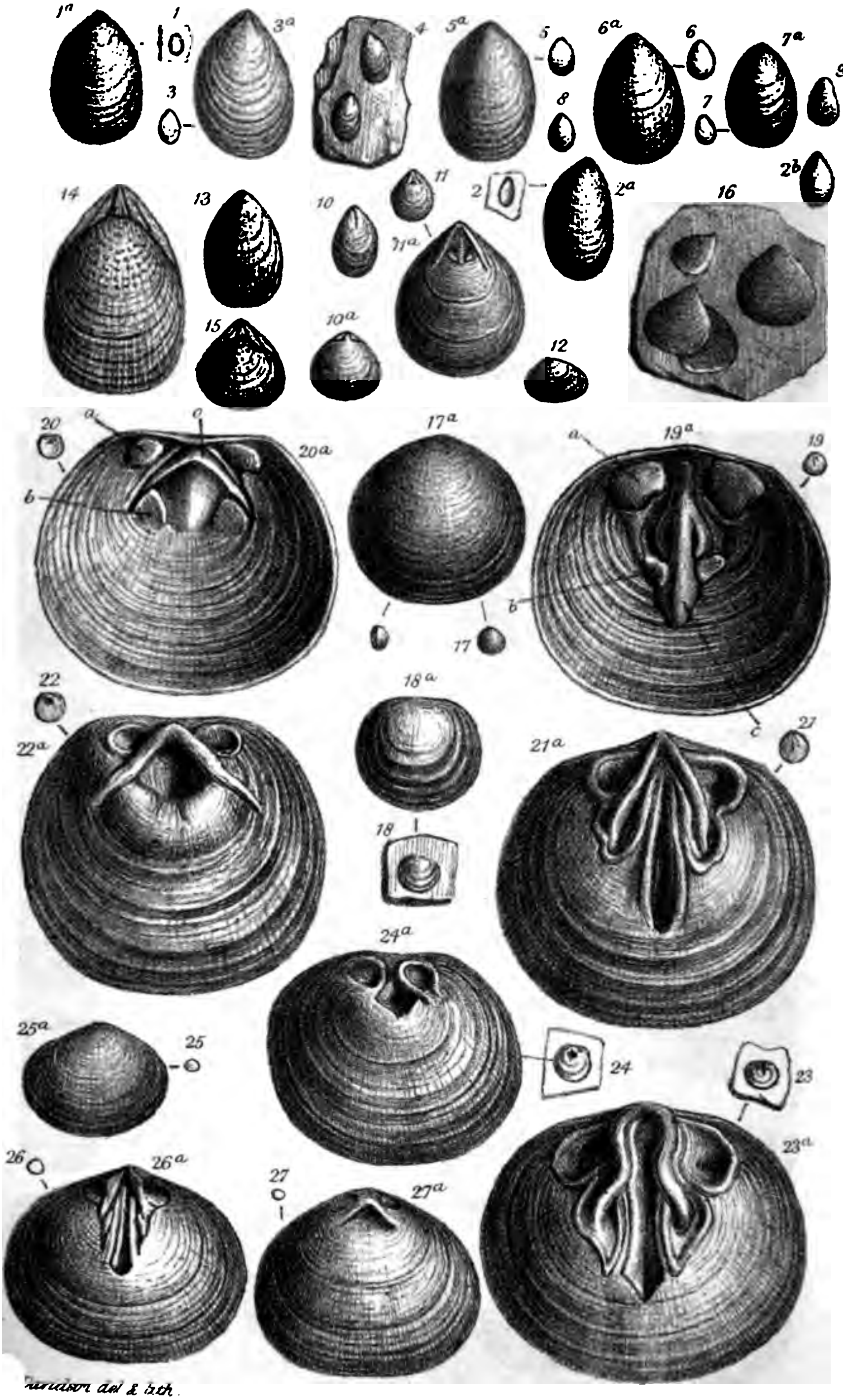
[1] Dr. S. P. Woodward, in "Critic," 1860, No. 12.

[2] Maury, p. 56.

[3] Dr. S. P. Woodward, in "Critic," 1860, No. 10.



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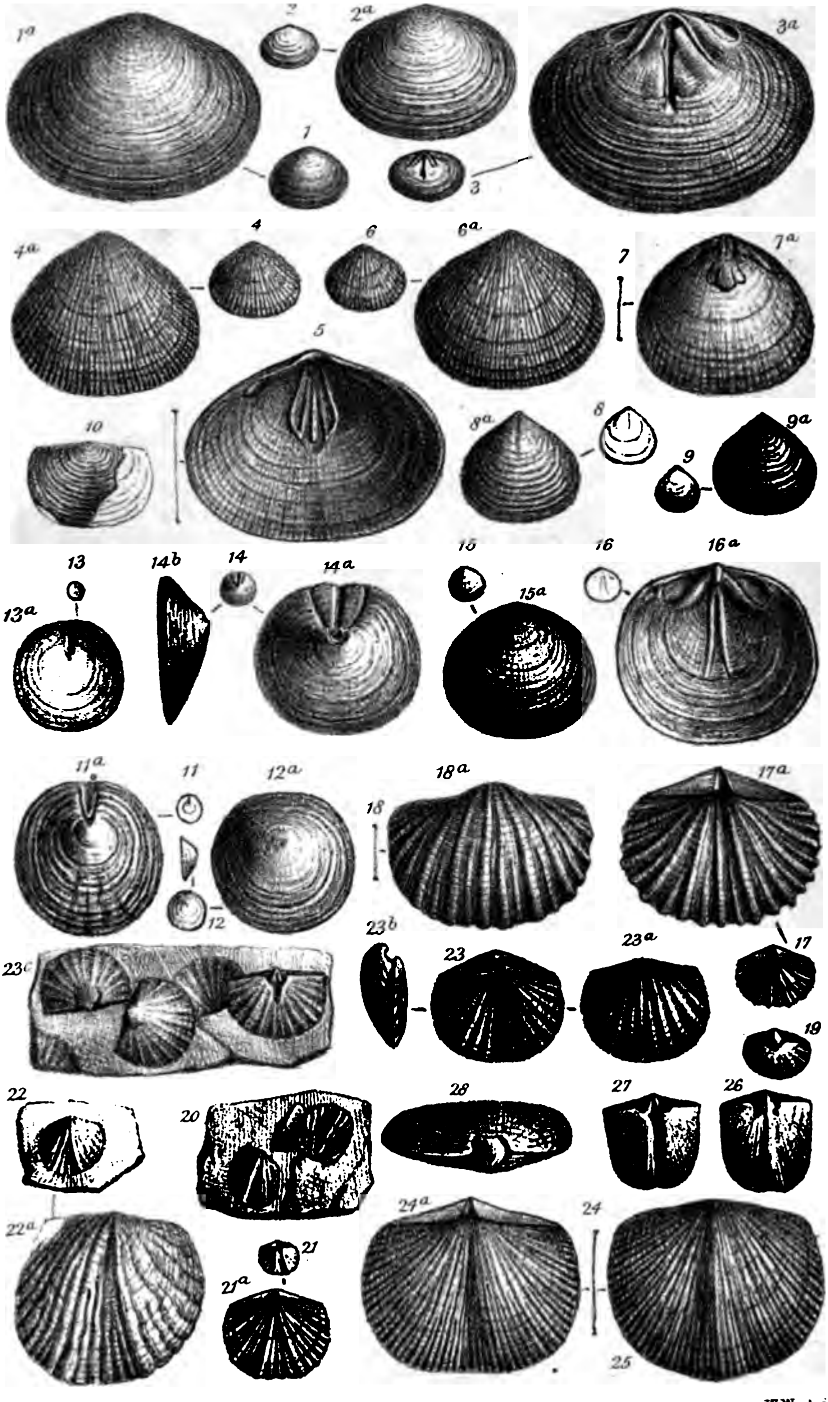
Earliest forms of British Brachiopoda.

Geol. Mag. 1868. Vol. V. Pl. XV



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Earliest forms of British Brachiopoda.

From the foregoing statements it will be seen that even with the small amount of the Gulf-stream directed towards our shores, how great is the benefit we derive from the warmth which its waters impart to our atmosphere throughout the year. If, by a slight alteration of the trend of the land, its main body (now to a great extent deflected back upon the N. W. coast of Africa) were compelled to pass northwards into the Arctic Ocean, how enormous would be the influence it would exert on the climate of Norway, Spitzbergen, and Siberia!—Or, on the contrary, suppose the cold northern current to descend on our shores and the *full force* of the Gulf-stream to be poured upon the shores of Greenland and Labrador, unchecked by the banks of Newfoundland, and any projecting lands; again, the Glaciers of these ice-locked lands would recede to their highland retreats, and all the valleys would become clothed with verdure, and be capable of supporting the vegetation of the warmer temperate regions, now only found there in a fossil state.—H. W.

II.—ON THE EARLIEST FORMS OF BRACHIOPODA HITHERTO DISCOVERED IN THE BRITISH PALÆOZOIC ROCKS.

By THOMAS DAVIDSON, Esq., F.R.S., F.G.S., etc.

[PLATES XV. & XVI.]

THE study of the earliest fossiliferous rocks, as well as that of their animal remains, has been, and will be for a long time to come, a subject of very considerable interest, and one that has, especially during the last few years, attracted the keen attention of several experienced and conscientious observers. Many have been the observations assembled in connection with the direct order of superposition and relative age of the various rocks composing the Cambrian and Lowest Silurian deposits, as well as in seeking out all the data that could be obtained, so as to enable the palæontologist to attempt a correct diagnosis of the very earliest known ancestors of many of our fossils. The discoveries effected by Sir W. Logan amongst the 'Laurentian' rocks of North America (as stated by Sir R. I. Murchison) "constitute the foundation stones of all Palæozoic deposits in the crust of the globe wherever their formations are known;" and with what keen interest has not the *Eozoon* been welcomed and elaborated—the oldest animal known!

The important discoveries of Barrande amongst the 'Primordial rocks' of Bohemia have also thrown considerable light upon the life of that remote period, and it is truly wonderful that these animal remains should have been preserved to us in so complete a manner after the countless ages that have elapsed since the time of their final extinction. The creative power seems to have been always in operation, and as one set of organisms had served their time and purpose, they were either gradually or more suddenly modified or replaced by others more suited to the period at which they were called into existence. Now, setting aside the *Eozoon* as the oldest animal form on record, it becomes most interesting to seek out the exact period at which the next animal, or series of animals, made their appearance in the waters of our globe. It will, therefore be my object in this brief communication to investigate the earliest Brachiopoda that have been discovered up to the present time in the 'Primordial rocks' of Great Britain. I had hoped, it is true, that my friends, Messrs. J. W. Salter, H. Hicks, T. Belt, E. Williamson, J. Plant, and same others, who have devoted so much time to the study and elaboration of the Cambrian and Lowest Silurian rocks of North and South Wales, and who, during their lengthened investigations, had assembled so many specimens, would have likewise completely worked out the new species of Brachiopoda they had discovered; but as a desire was expressed that such should be done by myself, I will now endeavour to carry out their wishes, although the task involves a certain amount of difficulty, from the circumstance that several of the species are very minute and occur only under the condition of internal casts and more or less perfectly preserved external impressions.

It would not be possible in the short space into which the present communication must be compressed, to even refer to the many very important geological or stratigraphical labours that have been published upon these primordial rocks and fossils by Sir R. I. Murchison, the Rev. A. Sedgwick, Prof. Ramsay, Messrs. Salter, Hicks, Belt, and several others;[1] but with the kind assistance of the last two named gentlemen, an attempt has been made to tabulate the vertical range of strata, as well as of each of the species of Brachiopoda, so far as such was practicable, and I will consequently, without further preamble, proceed to describe the various forms that have come under my notice:—

Genus Lingulella, Salter, 1861.

At page 55 of my Silurian Monograph will be found a full description of this genus, so far as we are at present acquainted with its internal characters. I was, therefore, somewhat surprised while reading in the twenty-third volume of the Quarterly Journal of the Geological Society (p. 341), "that I had shown a bad example by merging *Lingulella* into *Lingula* (though the one has a pedicle groove and the other has not)." If I, therefore, revert to this, no doubt, unintentional mistaken statement, it is simply in order to reiterate that I adopt *Lingulella* as a section in the great family *Lingulidæ*, and, as far as my observations extend, that all the specimens of the genus hitherto discovered in the ancient Palæozoic deposits of our British Islands would be referable to the three following species:—

1. Lingulella Davisii, M'Coy. Pl. XV. Fig. 13–15.

This is the largest, but not the most ancient species of the genus

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[1] My thanks are also due to Messrs. J. Plant, R. A. Eskrigge, G. H. Morton, D. Homfray, and J. C. Barlow for the communication of their specimens; but particularly to Messrs. H. Hicks and T. Belt, who have presented me with a fine and extensive series of specimens collected by them in North and South Wales.

Vertical Range of the Earliest Genera and Species of Brachiopoda in the Lowest Palæozoic Deposits of Great Britain.

The black lines indicate the range of the species at present known.	Laurentian (Sir W. Logan)	Cambrian (Murchison).		Primordial Silurian (Murchison).				Lower Silurian (Murchison).			
		Lower Cambrian (Sedgwick).			Upper Cambrian (Sedgwick).						
					Ffestiniog Group (Sedgwick).						
Species.		Llanberis Slates. Lower Longmynd. (Murchison)	Harlech Group. (Sedgwick). Upper Longmynd. (Murchison)	Menevian Group. (Salter and Hicks.) Lower Lingula Flags.	Maentwrog Group. (Belt). Middle Lingula Flags.	Dolgelly Group. (Belt.) Upper Lingula Flags.	Tremadoc Group. (Salter.) Tremadoc Slates. (Murchison.)	Arenig or Skiddaw Group. Lower Llandeilo. Lower. Upper	Llandeilo Flags. Lower. Upper	Caradoc.	Lower Llandovery.
Lingulella ferruginea, Salter.	....	....	———	———	...? ...	...? ...	...? ...				
„ *Davisii*, M'Coy ...	....	....	....	....	———	———	———				
„ *lepis*, Salter	....	....	....	....	....	...? ...	———				
Lingula squamosa, Holl.......	....	....	....	....	...——						
„ *pygmæa*, Salter											

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described in my S characters
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that the two inc while the
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2. Lingulella ve features,
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[1] "The little spec ather more
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oldest animre at present acquainted; and as it has been fully
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made their xisted during the larger portion of the Middle and
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earliest Braɜ 'Tremadoc period.' I am not, however, satisfied
time in the›mplete specimens (Pl. XV. Fig. 9), found by Mr.
is true. thatdivision of his 'Maentwrog Group,' do really be-
E. Williamses under description. *L. Davisii* is very abundant
time to thedoc, at Whitesand Bay, St. Davids, and in several
Silurian roc
lengthened i FERRUGINEA, Salter. Pl. XV. Fig. 1–8.
have likewi*guiculus*, Salter. Report of the British Association,
they had dis1865 = *L. ferruginea* and *L. ferruginea var. ovalis*,
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although 'thıarterly Journal Geol. Soc. (Vol. xxiii. p. 340), 1867.
circumstanc:ies has been correctly described and illustrated by
only under s, as far as we are aware, the earliest Brachiopod
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communicatp of Sedgwick, which directly underlies the Mene-
important gwest Lingula flags,[1] and where it does not appear
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chison, the imen kindly examined and pronounced by you (Mr. Davidson) to
Belt, and as recently found by me at Porthclais Harbour, near St. David's,
beds belonging to the purple and red Cambrian rocks, exposed in
last two naıat the very base of a series looked upon as the equivalent of the
vertical randgwick and of the Upper Longmynds of Murchison, and directly
poda, so far grits and shales like those of North Wales and Shropshire.
out further re, is about 1200 feet lower in the series than the specimen
alter and myself in the Quarterly Journal of the Geol. Soc.
come under was found, as there stated, in one of the red beds of the
series; and also about 900 feet lower than the fauna subse-
ɔy me in the intermediate beds, consisting of new species of
At page *oxides*, *Microdiscus*, *Theca*, *Agnostus*, and *Discina*. It is un-
tion of thist Brachiopod hitherto found: and it furnishes one of the first
internal ch:es, yet obtained (next to the minute Rhizopod *Eozoon*), of so
ce of animal life upon our globe; lob-worms and fucoids claim,
reading in ntiquity, but they are not of so high a form of organization. The
Geological :des, in addition to the above-mentioned species of *Conocoryphe*,
merging Lother trilobite (*Palæopyge Ramsayi*) found by Mr. Salter in the
groove and e well-known *Oldhamia*, at Bray Head. These, inclusive, com-
yet discovered in the enormous series intervening between the
doubt, unind the Menevian group."—(H. Hicks).
iterate tha Group,' along with *L. ferruginea* in addition to the other
Lingulidæ, ;e group to be described in this paper, the following fossils have
mens of tl: *Paradoxides Davidis*; *P. Hicksii*; *P. aurora*; *Conocoryphe*
rosa; *C. applanata*; *C. bufo*; *Microdiscus punctatus*; *Anopolenus*
deposits o*i*; *Erinnys* (*Harpides*) *venulosa*; *Holocephalina primordialis*;
following s*A. Barrandii*: *A. Eskriggii*; *Leperditia solvensis*; *L. vexata*:
1. LINGU*ata*; *P. flabella*; *P. diffusa*: *Protocystites*, sp.; *Theca corrugata*;
This is t*ultima*; *Stenotheca cornucopia*; *Cyrtotheca hamula*; etc., etc. I
ind the reader that it is interesting to notice how important
is group has become within the last few years. In 1862 Mr.
[1] My thank finding fragments of *Paradoxides* and another Trilobite *Micro-*
Homfray, andf St. David's, and these were the first indications obtained of the
cularly to Mea. In the following year Mr. Hicks succeeded in discovering no
extensive seriew species in these beds; these now form the great and well-

to be very scarce, but the beds are much cleaved, and the colour is not in any way favourable to the exhibition of the characters of so thin a shell. *L. ferruginea* is a small shell, rarely much exceeding two and a half lines in length by some two in width. In external shape it is ovate, oblong, widest about the middle, broadly rounded in front, sides nearly parallel for some distance, while the beak is obtusely pointed. The valves are also very slightly convex, and marked with concentric lines of growth.

After an attentive comparison of the single example of the variety *ovalis* with a number of specimens of *L. ferruginea* from the 'Menevian Group,' I was quite at a loss to make out any distinctive features, and I find that Mr. Salter himself does not fail to observe that his variety is not to be distinguished from the other, "except by the front of the front edge, which is rounded off and not squared at all." However, this last character cannot be considered of any importance, for I have specimens before me of a similar size of *L. ferruginea*, which have the front quite as much rounded off as is seen to be the case in the single example of the var. *ovalis*. There can also be no doubt as to the shell originally termed *unguiculus* (in 1865), being the same species as the *L. ferruginea* described in 1867. *L. ferruginea*, it is true, like most of its congeners, varies slightly in its shape in different examples; some, therefore, have their front a little more rounded than others, and the posterior portion converges rather more in some individuals than it does in others. After a very minute study of a number of specimens submitted to my examination by Messrs. Hicks and Belt, it appeared to me that the shell under description made its first appearance in the lowest beds of the Harlech period, and continued to live during the whole of the 'Menevian' or 'Lower Lingula flags,' and was very probably, if not certainly still existing, during the period of the deposition of the Middle and Upper Lingula flags; for several examples much resembling Salter's species were met with by Mr. Belt in his 'Dolgelly and other divisions (?).' This, however, must still remain an undecided question, for several specimens of *L. læpis* can hardly be distinguished from *L. ferruginea*, and in this predicament we find the small specimen found by Mr. Hicks at Rhyw-felyn, near Mawddach, North Wales (Pl. XV. Fig. 7). *L. ferruginea* occurs in the 'Menevian' rocks of St. Davids, as well as at Camlan, Tafern Helig, Waterfall Valley, near Maentwrog, and several other places in North Wales, also in the Harlech grits of Solva and St. David's.

3. LINGULELLA LÆPIS, Salter. Pl. XV. Figs. 10–12.

Memoirs of the Geological Survey of Great Britain (Vol. iii. pp. 334, fig. 11, 1866).—This species appears to slightly exceed *L. ferruginea* in its dimensions, and is perhaps wider in proportion to

known fauna of the 'Menevian Group,' which has been proved subsequently to extend not only through much of the N.-West of Pembrokeshire, but also in various districts in North Wales, and always to contain the same species as those first found in the district. Mr. T. Belt's valuable researches on the 'Lingula Flags' will be found recorded in Vols. IV. and V. of this MAGAZINE.

its length, but, in other respects, does closely approach in external shape to the shell last described. Thanks to the kindness of Mr. Homfray, I have been able to examine a very interesting series of specimens of this species which he had obtained from the 'Lower Tremadoc' at Penmorfa Church, near Portmadoc, in North Wales. It is, however, much to be regretted that the shell rarely presents its true or normal condition, having been much distorted during the process of fossilization.

Genus LINGULA, Bruguière, 1789.

Well-authenticated species of *Lingula* do not appear to have been discovered lower down than the 'Middle Lingula flags,' where the genus would be first represented by *L. squamosa*—it is true, a badly-made-out species—while *L. pygmea,* another uncertain species, was found in the 'Upper Lingula flags.' In the 'Arenig or Skiddaw Group' we have *L. petalon,* but it is chiefly in the 'Llandeilo flags' that the genus begins to be represented by such shells as *L. attenuata, L. brevis, L. granulata, L. Ramsayi,* and one or two others.

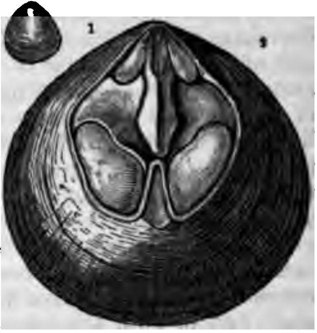
LINGULA PETALON, Hicks, M.S. Pl. XV. Fig. 16.

Shell small, broadest about the middle, from whence it becomes rapidly obtusely rounded; valves much flattened and marked by concentric lines of growth; length 5, width 4½ lines.

This shell was found for the first time in 1864, by Mr. Hicks, in the Upper and Lower Arenig or Skiddaw group, at Whitesand Bay, near St. David's; also, subsequently, in the same formation in Ramsay Island, and Tremanhire, but in no other group. It much approaches in shape to some forms of *L. attenuata,* but this last-named shell is usually larger and more elongated.

Genus OBOLELLA, Billings.

In 1861 Mr. Billings proposed the genus *Obolella* with the following diagnosis: "Shell oval, circular or sub-quadrate, convex, or plano-convex. Ventral valve with a false area, which is sometimes minute, and usually grooved for the passage of the peduncle. Dorsal valve either with or without an area. Muscular impressions in the ventral valve, four: one pair in front of the beak, near the middle or in the upper half of the shell, the other pair situated one on each side near the cardinal edge. Shell calcareous, surface concentrically striated, sometimes with thin expanded lamellose ridges. In general form these shells somewhat resemble *Obolus,* but the arrangement of the muscular impressions is different. In *Obolus,* the two central scars have their smaller extremities directed downwards, and converging towards each other; but in this genus the arrangement is exactly the reverse." Such is Mr. Billings's diagnosis, but I fear it will require some little modification in its details, if it is to comprise *O. chromatica* (the type), *O. ? polita, O. desiderata, O. Sagittalis, O. maculata, O. ? Salteri,* and several other species. Unfortunately the American material in my possession is not sufficiently complete to enable me to determine the point in question; the interior of one of the valves of *O. desiderata* being the only one I have been able to examine, and of which I here append a figure. The interior of *O. polita* will be found figured in the 16th Annual Report of the Regents of the University of the State of New York for 1863, and some complete illustrations of both valves of *O. Sagittalis* are here given. Having sent drawings of these last to Mr. Billings, he wrote back, "Your figures show the four muscular scars of *Obolella*, but their proportions are quite different from those of *O. chromatica*, *O. desiderata*, and *O. polita*. In Hall's figures of *O. polita*, the muscular scars agree with those of my species as nearly as two forms of the same genus usually do, but the two anterior scars are vastly larger in proportion to the size of the shell, than they are in *O. Sagittalis*." I cannot, however, find any hinge area in the last-named shell, nor groove for the passage of a pedicle, this being visible only so far as I can make it out in *O.? polita*.



1. Exterior of *Ob. desiderata*, nat. size.
2. Internal cast of the same greatly magnified.

OBOLELLA SAGITTALIS, Salter, M.S. Pl. XV. Figs. 17–24.

Named only in the Report of British Association (p. 285), 1865.

Discina labiosa, Salter, ditto. ditto.

Shell small, rarely exceeding two and a half lines in length and breadth; almost circular, rather broader anteriorly, front broadly rounded, beak in the dorsal valve slightly obtusely pointed, posterior margin in the ventral valve nearly straight or slightly indented in the middle. Valves convex, and more or less deeply marked by concentric lines or ridges of growth. In the interior of the dorsal valve two rather large, irregularly circular, projecting scars (*a*., Pl. XV. Fig. 19) are situated close to the posterior margin, and separated by a moderately elevated tongue-shaped ridge which extends to about two-thirds of the length of the valve (*c*), and on either side, at about half the length of the valve, are two smaller oval-shaped, divaricating, slightly-prominent scars (*b*). (In the cast these projections form corresponding depressions, but they vary considerably in their minor details according to age and specimen.) In the interior of the ventral valve, two oval-shaped, obliquely-placed scars, smaller than the corresponding ones in the opposite valve, and more widely separated, lie also close to the posterior margin (*a*). A little lower down, two rather larger, but very slightly marked, scars may be noticed; while between the four muscular impressions a projecting Λ-shaped ridge, with most elevated portion (*o*) in the middle, lies between the first-named scars, and leaves in the cast a deepish angular depression which assumes, at first sight, resemblance to an apicial foramen.

This well-marked species was named by Mr. Salter in 1865, but was not figured or described. It is tolerably abundant under the condition of internal casts, which are sometimes very sharply marked, so that, I trust, I have been able to define its internal characters in a sufficiently satisfactory manner. I was, moreover, able to demonstrate that the so-termed *Discina labiosa* had been established on the internal cast of the ventral valve of the species under description. This I ascertained, beyond doubt, first from finding the casts of both valves of *O. Sagittalis* abundantly spread over the same slabs; secondly, because the casts agreed exactly in their respective dimensions ; and, thirdly, because, having, by the aid of gutta percha, taken moulds from these casts attributed to *D. labiosa,* it became evident that the hollow, supposed to be due to a foraminal aperture, was nothing more than a prominence in the interior of the shell, as we have already described as existing between the four muscular scars. Now, if we compare the interior of the dorsal valve with the corresponding one in *Crania,* we shall find in both the same large scars (*a*), which in that genus have been attributed to the divaricator muscle (Hancock), whilst those marked (*b*) would have been produced by the occlusor or adductor muscle, and if the animal possessed 'anterior occlusors,' they would, as in *Lingula,* occupy the sides of the projecting tongue-shaped ridge at the place marked (*c*). Here, therefore, as in *Crania,* the divaricator scars are larger than are the occlusor or adductor ones. In *Obolus* the scars (*b*) are larger than those marked (*a*), and in addition to these on either of the lateral portions of the interior of the valve are two other scars, not visible here. There is also a total absence of hinge-area or groove for the passage of a peduncle, so constant in *Obolus.* Nor do we find any trace of that flattened internal margin which surrounds the valves in *Crania.* If we again compare the interior of the ventral valve with that of *Crania,* we should in both cases refer the scars (*a*) to the divaricator, while the feebly-marked ones (*b*) would be attributable to the occlusor.

Position and locality.— From the researches of Messrs. Hicks, Salter, and Belt, this remarkable and characteristic species appears to be moderately plentiful throughout nearly the whole of the 'Menevian group,' but it is still uncertain whether a minute, obscurely-marked specimen found by Mr. Hicks in the upper portion of the 'Harlech group,' and which underlies the 'Menevian,' may not belong to the species under description. A still more minute shell, found tolerably abundantly by Mr. Belt in the Lower Tremadoc beds of Craig-y-dinas in North Wales, if not totally distinct from the present species, would at any rate constitute a well-marked variety, or even, perhaps, species; which we will, at least, provisionally, retain under the distinctive denomination of *O. Belti.* *O. Sagittalis* was obtained by Mr. Hicks for the first time at Porth-y-rhaw, and subsequently at Penpleidau, and several other places near St. David's, also by Mr. Homfray in the beds of the Menevian formation at the Rheider Waterfall Valley and other places in North Wales. Mr. Belt obtained it also at Gwynfynydd and in several other localities in the neighbourhood of Dolgelly.

OBOLELLA BELTI, Dav. Pl. XV. Figs. 25–27.

Shell small, less than a line in length by about one line in breadth; transversely oval, beak acuminated, front broadly rounded. Valves moderately convex and marked by concentric lines of growth. Lower Tremadoc, Craig-y-dinas, North Wales. The internal characters agree pretty closely with those already described in *O. Sagittalis.*

Obolella maculata, Hicks, M.S. Pl. XVI. Figs. 1–3.
Report Brit. Assoc. (p. 285), 1865.

Shell small, transversely oval, valves moderately convex: four lines in length by five in breadth; beak very obtusely acuminated, front broadly rounded, greatest breadth at about the middle of the shell; surface smooth, marked only by fine concentric lines of growth. Interior incompletely known.

It has unfortunately not been possible to offer a description of the internal characters of this interesting fossil. I have, however, attempted to draw what little was clearly observable of its interior. *O. maculata* differs considerably from *O. Sagittalis,* both on account of its much larger dimensions and very transverse shape. The shell appears also to have been much thinner than that of the species last named, and is often found in a much compressed or flattened state in the rock in which it is imbedded. *O. maculata* was found by Mr. Hicks to occur chiefly in the middle portion of the 'Menevian Group' at Porth-y-rhaw, St. David's. Mr. Belt obtained it from the 'Lower Menevian' at Camlan, and in the lower portion of the group at Gwynfynydd in North Wales.

Obolella ? Salteri, Holl. Pl. XVI. Figs. 8 and 9.

With reference to the genus to which this apparently rare species should be referred, some uncertainty must still prevail, for we have not yet seen its interior. It has been stated to occur in the 'Upper Lingula flags' in the Malvern district. Mr. Belt has also found some specimens which I cannot distinguish from *O. ? Salteri* in the 'Lower Tremadoc' at Craig-y-dinas, in North Wales. There would be nothing improbable in this species having passed from the Ffestiniog group into the overlying 'Tremadoc' one.

Genus Obolus, Eichwald, 1829.

Obolus ? plumbea, Salter. Var. *plicata,* Hicks, M.S. Pl. XVI. Figs. 6 and 7.

While describing the exterior of *Obolus ? plumbea* at p. 61 of my Silurian monograph, I felt very uncertain as to the propriety of locating it with *Obolella;* since that period, through the kindness of Mr. Morton of Liverpool, I have been able to examine the interior of one of its valves (Pl. XVI. Fig. 5), and which leads me to infer that the shell under notice is more nearly related to *Obolus* than to *Obolella* ?.

After a lengthened study and comparison of a smaller form sent to me by Mr. Hicks under the designation of *Ob. plicata,* which occurs sparingly in the 'Lower Arenig or Skiddaw group' at Tremanhire and Ramsay Islands, near St. David's, in South Wales, I could not divest myself of the idea that this last was nothing more than a smaller variety of the typical form which occurs in the 'Upper Arenig' and 'Lower Llandeilo' rocks of North Wales. In external shape this variety '*plicata*' is slightly transversely oval, obtusely acuminated posteriorly, broadly rounded anteriorly, while the largest example I have been able to examine did not exceed four lines in length by five in width. The valves are slightly convex, and marked by numerous fine thread-like radiating bifurcating striæ. No sufficiently perfect interior having been discovered, I cannot attempt to describe its internal characters, but I have drawn the obscurely-marked impressions observable on a single internal cast that has fallen under my notice. I must also here observe that Mr. Hicks admits the possibility of his *O. plicata* being a small variety of *O. plumbea.*

Genus KUTORGINA, Billings, 1861.

The characters of this genus (?) have not yet been discovered or described, but the exterior presents some remarkable peculiarities.

KUTORGINA CINGULATA, Billings. Pl. XVI. Fig. 10. Geol. Survey of Canada. Pal. Fossils, Vol. i. p. 8, figs. 8, 9, 10 = *Obolella*? *Phillipsii*, Holl, etc. Dav. Sil. Mon., p. 62. Pl. 17–19.

While preparing the first portion of my Silurian Monograph, I felt very uncertain as to the genus and species to which the so-termed *O. Phillipsii* should be referred; since then, thanks to the kindness of Mr. Billings, I have been able to compare his Canadian type of *Kutorgina cingulata* with a similar sized example of *O. Phillipsii*, kindly presented to me by the Rev. W. S. Symonds. I was also able to show these specimens to Dr. Holl, and he at once agreed with me that his *O. Phillipsii* and the American shell belonged to a single species. Neither, however, were at all referable to the genus *Obolella*, their long straight hinge-line precluding such a possibility. The term *O. Phillipsii* must consequently be considered as a synonym, Billings's name claiming priority of publication. Dr. Holl informs me also that the Potsdam Sandstone and shale, in which the *K. cingulata* is said to occur, occupies (he thinks) as nearly as possible the position of our "Lingula beds," and all along the Appallachian chain, rests like our Hollybush Sandstone, unconformably on old Metamorphic rocks, which resemble precisely, and occupy the same position as those of the Malverns. Dr. Holl suggests the upper position of the Middle Lingula flags as the stage at which *Kutorgina cingulata* would occur.

DISCINA PILEOLUS, Hicks, M.S. Pl. XVI. Figs. 11 and 12. Report of Brit. Assoc. (p. 285), 1865.

Shell very small, circular or slightly longitudinally oval, rather broader anteriorly, about two lines and a half in length and a little less in breadth. Dorsal valve conical, ventral valve slightly convex or depressed near the margin; vertex in both always at a short distance from the centre, as also the foramen (?) in the ventral valve. Surface marked with concentric lines, which are more strongly marked in the ventral one. Interior not known. Mr. Salter was the first to detect the presence of this genus in the 'Menevian group,' and the species under description subsequently received the designation of '*pileolus*' from Mr. Hicks, for we have already stated that the so-termed *D. labiosa* (Salter) was founded on the internal cast of the ventral valve of *O. Sagittalis*. *D. pileolus* was found by Mr. Hicks to occur in the Middle (Sandstone) beds of the 'Menevian group' at Porth-y-rhaw, Ninewells, and Solva Harbour, St. David's, where it is scarce and usually very imperfectly preserved. One specimen of a minute *Discina* (Pl. XVI. Fig. 13) appears to have been obtained by Mr. Hicks in one of the yellowish grey beds of the 'Harlech group,' on the road leading from Solva to Whitechurch, St. Davids; and if it should turn out to be the same as the shell under description, which it appears to resemble, it would be the oldest form of the genus known, and one of the earliest Brachiopoda on record. *D. pileolus* was also found by Mr. Belt in the 'Menevian' stage at Camlan in North Wales.

Genus ACROTRETA, Kutorga, 1848.

ACROTRETA ? NICHOLSONI, Dav. Pl. XVI. Figs. 14–16.

Shell small, about two lines in length by about the same in breadth, almost circular, rather wider and broadly rounded anteriorly, nearly straight posteriorly; dorsal valve very slightly convex; ventral valve conical, apex sub-central and truncated by a minute circular foramen, which is situated at a little more than one-third of the length of the valve. From the centre of the posterior margin a narrow groove or channel extends to the base of the foramen, while on either side a small flattened triangular space or false area (?) is limited by an indented line. Surface of both valves marked with numerous concentric lines of growth.

Although the species under description has not, as far as I am aware, been hitherto found in Wales, it will be desirable to introduce it here, as it is new to Great Britain, and another of those minute and curious forms that have been discovered subsequent to the publication of the first portion of my Silurian Monograph. Several examples of this interesting little species were sent to me in Feb., 1867, by Dr. H. A. Nicholson, their discoverer, under the designation of *Siphonotreta micula*, but I soon perceived that they could not be identified with that genus or species, and although I am by no means confident as to the propriety of locating it in *Acrotreta*, this last is the genus to which our Scottish shell seems to bear the closest resemblance. One valve being nearly flat, the other conical, with a minute perforation at its apex, the longitudinal groove or canal and false area,—all being external features peculiar to the Russian genus. However, as we know nothing of the interior of *Acrotreta*, and very little of the Scottish shell, the true generic position of this species must be viewed as provisional. *A. ? Nicholsoni* occurs in black shales in the *Upper Llandeilo* ? of Dobb's Linn, near Moffat in Dumfriesshire, whilst *Siphonotreta micula* is found at Hart Fell, or Glenkiln Burn, near Moffat, in distinct beds. *Siphonotreta micula* is, strictly speaking, a 'Llandeilo flag' species, but Mr Hicks believes he has found it, or another undeterminable allied form, in the upper portion of the 'Arenig group' at Whitesand Bay, St. David's.

GENUS ORTHIS, Dalman, 1827.

It will not be necessary here to enter into a lengthened account of the earliest species of the genus *Orthis*, since they will be very shortly minutely described and illustrated in the third portion of my Silurian Monograph now in the press. *Orthis* is one of the earliest genera of Brachiopoda at present known, for it is represented by a single species in the rocks of the Menevian period. It is followed up by a fresh species in the Upper Lingula flags, and by other two new forms in the Arenig, or Lowest Llandovery period.

ORTHIS HICKSII, Salter, M.S. Pl. XVI. Figs. 17-19.

Shell small, measuring about four lines in length by five in breadth, transversely oval, hinge-line shorter than the greatest breadth of the shell, cardinal angles rounded. Dorsal valve semicircular, moderately convex, slightly longitudinally depressed along the middle. Ventral valve convex, deeper than the opposite one. Area triangular, moderately wide. Surface of valves ornamented by about ten principal narrow radiating ribs, with wide interspaces between each pair, in the middle of which is situated a shorter rib. *O. Hicksii* is a scarce fossil, and very rarely found in a complete condition. It was discovered by Mr. Hicks in the Middle (Sandstone) beds of the Menevian Group, at Ninewells and Porth-y-rhaw, near St. David's, and is the oldest species of the genus on record. It was named after Mr. Hicks by Mr. Salter, but was not figured or described. It has not been found as yet in North Wales.

ORTHIS LENTICULARIS, Dal. sp. Pl. XVI. Figs. 20-22.

This small species has been described at some length by Mr. Salter, at p. 339 of vol. iii. of the Memoirs of the Geological Survey of Great Britain. It occurs in the Upper Lingula flags (Dolgelly group of Mr. Belt), at Ogof-ddu, Criccieth, near Portmadoc; Penmorfa Church, Tremadoc; at Gwerny-y-Barcud, Rhiwfelyn, and in several other Welsh localities. It is immensely abundant in some beds, but usually of very small dimensions, and very much distorted from the effects of cleavage, so that it is all but impossible to obtain a complete example.

ORTHIS MENAPIÆ, Hicks, M.S. Pl. XVI. Figs. 24-28.

Shell truncate-orbicular, rather wider than long; hinge line a little shorter than the greatest width of shell. Dorsal valve semicircular, slightly convex, with a longitudinal depression or sulcus. Ventral valve rather deeper than the opposite one, with a longitudinal ridge commencing at the extremity of the small incurved beak, and gradually widening as it nears the front. Area rather narrow. Surface of both valves covered by numerous fine bifurcating striæ. About seven lines in length by eight or nine in width.

O. menapiæ is a well-marked species, but is nearly always more or less out of shape from the effects of cleavage and fossilization. It was discovered for the first time by Mr. Hicks at the base of the Arenig group, or Lowest Llandeilo, at Tremanhire, and subsequently at Llanveran, Ramsey Island, and Whitesand Bay, all near St. David's. The designation *menapiæ*, assigned it by Mr. Hicks, is the classical name for the earliest city mentioned in the St. David's district. It occurs in company with the following species, but is easily distinguished from it by its shape, as well as by the number and strength of its striæ.

ORTHIS CARAUSII, Salter, M.S. Pl. XVI. Fig. 23.

Sub-orbicular, rather wider than long; hinge-line the same or a little less than the width of the shell. Slightly indented in front. Dorsal valve gently convex with a longitudinal depression along the middle. Ventral valve deeper than the opposite one; beak small incurved. Area rather narrow. Surface of valves covered with about sixteen simple rounded ribs, and concave interspaces of about equal breadth. Length seven, width eighth, depth three lines.

This important species was discovered in the Lower Arenig Rocks of St. David's by Mr. Hicks about the year 1864, the shell occurring in vast abundance in the condition of internal casts and external impressions in yellow sandstone at Tremanhire, and in an extraordinary state of distortion in darker shales at Llanveran, Whitesand Bay, and at Ramsey Island, St. David's. Indeed, so great is the state of distortion from the effects of cleavage that one example found by Mr. Homfray at Llanveran measured five lines in length by twenty-seven in width, while the width of the shell prior to fossilization would not have exceeded seven or eight. In other cases the shell was similarly elongated or twisted to one or other side in the most irregular possible manner.

With these few remarks I will conclude; the whole subject in connection with this paper will in due time be more fully elaborated in my large Silurian Monograph.

EXPLANATION OF PLATES XV. & XVI.—PLATE XV.

Fig. 1. *Lingulella ferruginea* (var. *ovalis*), Salter, from purple beds of the Harlech group, St. David's. Fig. 1*a*, magnified.

2*a*, *b*. „ „ from Porthclais Harbour, near St. David's, from the lowest beds of the purple and red Cambrian rocks and the earliest Brachiopod hitherto discovered; 2 and 2*a*, nat. size; 2*a*, enlarged.

3–8. „ „ 3 and 4 from the 'Menevian,' St. David's; 4 nat. size, after Mr. Salter's original figures; 5 from Penmorfa, Tremadoc (Upper Dolgelly group of Belt); 6 from Gwern-y-barcud (Upper Ffestiniog); 7 from Rhiwfelyn (Upper Dolgelly beds); 8 from Tremadoc or Arenig group at Waun-feddu, Dolgelly. With reference to Figs. 5 to 8, some uncertainly may still prevail, although they very probably belong to *L. ferruginea*.

9. „ ? specimen referred to *L. Davisii* by Mr. Belt from above Dolgelly, in his Upper Maentwrog beds.

10–12. „ *lepis*, Salter, different forms from Penmorfa church Portmadoc, Lower-Tremadoc. 10*a*, *b*, two of Mr. Salter's original figures.

13–15. „ *Davisii*, M'Coy. 13, perfect specimens from Upper Lingula flags near Portmadoc; 14, internal cast; 15, small specimen out of shape from Gwern-y-barcud, Upper Ffestiniog.

16. *Lingula petalon*, Hicks. Arenig rocks, Whitesand Bay.

17–24. *Obolella Sagittalis*, Salter. A series of interiors and internal casts of both valves, with figures greatly magnified, the small ones being of natural size from the Menevian rocks of St. David's. Fig. 19, interior of dorsal valve; 20, interior of ventral valve, Mawddach Waterfall, Dolgelly.

25–57. „ *Belli*, Dav. 25*a*, 27*a*, and 26*a*, enlarged. Lower Tremadoc, Craig-y-dinas, North Wales.

PLATE XVI.

Fig. 1–3. *Obolella maculata*, Hicks, "Menevian Group," Porth-y-rhaw, St. David's, South Wales, and Gwynfynydd and Camlan, North Wales. 1*a*, 2*a*, 3*a*, magnified.
4. *Obolus ? plumbea*, Salter, exterior, Lower Llandeilo, Wellfield Builth.
5. „ „ „ interior, from Shelve, enlarged.
6. „ „ var. *plicata*, Hicks, exterior, Tremanhire, St. David's, Lower Arenig Rocks.
7. „ „ „ „ internal cast of same enlarged.
8. *Obolella ? Salteri*, Holl. Malvern, from original specimens.
9. „ „ ? Lower Tremadoc, Craig-y-dinas, N. Wales.
10. *Kutorgina cingulata*, Billings = *Ob. Phillipsii*, Holl. a large specimen. Malvern.
11–12. *Discina pileolus*, Hicks, "Menevian," Porth-y-rhaw Valley, St. David's. 11*a*, 12*a*, enlarged.
13. „ ? „ from the yellow fossiliferous beds in the Harlech Group, St. Davids. 13*a* enlarged.
14–16. *Acrotreta ? Nicholsoni*, Dav. Upper Llandeilo, Dobb's Linn, Moffat. 14*a*, 15*a*, 16*a*, enlarged.
17–19. *Orthis Hicksii*, Salter, "Menevian," Porth-y-rhaw, St. David's.
20–22. „ *lenticularis*, Dal. Upper Lingula flags, Ogaf-ddu.
23. „ *Carausii*, Salter, Arenig Rocks (Lowest Llandeilo) St. Davids.
24–28. „ *menapiæ*, Hicks, „ „ „

III.—ON THE VALUE OF THE EVIDENCE FOR THE EXISTENCE OF THE MAMMOTH IN EUROPE IN PRE-GLACIAL TIMES.

By W. BOYD DAWKINS, M.A., F.R.S., F.G.S.

EUROPE during the Tertiary period was invaded by successive races of animals driven from their head quarters by press of numbers or by famine, or allured by some modification of circumstances that was specially adapted for their well-being, in precisely the same way as it was subsequently invaded by successive races of men. Eocene Mammals were followed by Miocene, and those again by Pliocene, Pliocene by the Pre-glacial division of the Pleistocene, and, finally, the latter by the Post-glacial or Quaternary, in obedience to the same natural laws which compelled the Stone- to vanish away before the Bronze-folk, and the Kelt to yield to the Teuton. The parallel between the conquest of Europe by the ancient mammalia and that by man is most exact. In both cases the conquering race absorbed a greater or less proportion of the conquered. Thus the *Hippopotamus major* and *Rhinoceros hemitæchus* of the Pliocenes of Italy lingered on in France and Germany in association with, or, as it were, in a kind of helotage to, the Post-glacial fauna, just as the Kelt still survives in the midst of his Teutonic conquerors in Britain. In both there is the same uncertainty as to the ancient head-quarters of each race, except the last one, from which the present inhabitants of Western Europe are descended. Professor Max Müller has traced the Aryan race from Central Asia northwards and westwards to the very extremity of Europe, eastwards and southwards throughout the length and breadth of India, Persia, and Ceylon, by the identity in the root-meaning of words throughout that vast area. M. Lartet,[1] in 1858, traced the Post-glacial Mammalia from the plains of Northern Asia and Siberia westward as far as the Pyrenees, their southern boundary being formed by a line passing between the Alps and the Caspian. Subsequently, in 1859, the discovery of the remains of the Mammoth at Rome compelled him to extend its range at least as far south as the valley of the Tiber, where it lived while the masses of tuffa which composed the seven hills of the Eternal City were being poured forth from active volcanos.

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[1] Comptes Rendus, tom. xlvi.

In the Post-glacial fauna the Mammoth occupies a very important position, on account of its great range and the fact that its large molars are those of all others the first to have attracted the attention of naturalists, as well as from the vast quantity of its remains which occur in a fossil state in Siberia. Any proposition therefore that affects it, affects also the whole question of the origin of the Post-glacial fauna. If it be proved that the animal existed in Europe in Pre-glacial times, then M. Lartet's admirable theory of the migration[1] of the Quaternary fauna into Europe after the Glacial epoch falls to the ground, and the animal loses all classificatory value in the determination of Pre- from Post-glacial deposits. The late Dr. Falconer towards the close of his life held that it dwelt in Europe at the time of the deposition of the forest bed of the Norfolk shore; and M. Lartet himself has been so convinced of the truth of his conclusion, that he has lately published an essay, in which he quotes the animal as one of those few which survived the physical changes that intervened between the Pre- and Post-glacial epochs.[2] If the animal lived here along with *Elephas meridionalis*, then it cannot be viewed as a fellow-immigrant with the Reindeer. It is, therefore a point of very high importance to determine the value of the evidence on which Dr. Falconer founded his conclusion, which we are able to do by the late publication of all his data in the magnificent work containing his scientific essays, and the more valuable portions of his private notes.[3]

The only remains of the Mammoth that can by any possibility be ascribed to the Forest-bed are those in the possession of the Rev. S. W. King, F.G.S., the Rev. John Gunn, F.G.S., and in the Woodwardian Museum at Cambridge. With reference to the first of these Dr. Falconer writes as follows, page 164[3]:—

"I have also examined two specimens of the first true molar, upper jaw of *Elephas primigenius*, in the collection of the Rev. S. W. King, from the Norfolk coast section, near Cromer. The specimens were carefully compared with a molar from Ilford, in the valley of the Thames, belonging to Mr. Prestwich.

"The specimen first to be noticed, marked No. 3, is labelled 'Picked out of *blue clay and black gravel* on beach, solid level, after scouring from shoot of cliff, in March, 1860 (Anderson, Cromer).'

"It is a very perfect example of an antepenultimate true molar, upper jaw right (t. m. 1) presenting the crown quite perfect. The crown is composed of twelve principal ridges, with front and back talons; the nine anterior ridges are worn, the rest intact, and enveloped in cement. The most anterior ridge is confluent in its disc with the adjoining talon disc. The second disc is confluently transverse, somewhat irregularly reniform in its contour, the convexity being directed backwards. The third is composed of three semi-detached, oblong discs, the worn digitations not having become quite confluent. The four or five posterior ridges are but very slightly affected by wear. The ground surface of the crown is broad relatively to the length of the molar; the ridges are high, thin, and closely compressed. The plates of enamel are decidedly thin, presenting no appearance of crimping or primary undulation, the only plicature shown being that produced by the confluence of the discs (that is, secondary undulations). In all these respects this molar bears a very close resemblance to Mr. Prestwich's Ilford specimen. The fangs are all broken off below, where, in the interstices, the matrix is distinctly seen, in some places penetrating into the hollow cores of the fangs. This matrix consists of a very ferruginous, fine sand, containing small pebbles, and closely agrees with the matrix of the Elephant-bed at Mundesley. There are also some patches of blue clay, resembling that of the laminated blue beds. There is no appearance of a disc of pressure behind, but this is intelligible from the semi-worn condition of the tooth. The fresh broken surfaces of the ivory of the fangs presents a dull cholocate, or pale sepia colour, like that of the Mammoth molars, from the 'Big-bone-lick' of America: it burns black and yields a strong odour of ammonia, proving abundance of gelatine. All this is against the remote age of the fossil, and it would indicate that it was yielded by some of the upper gravel beds or blue clay below the Boulder-clay than that it came out of the Elephant-bed. . . . . . I regard this specimen as being an antepenultimate of *Elephas primigenius*. N.B. The posterior talon is a little abraded behind.

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[1] Comptes Rendus, tom. xlvi., p. 409.

[2] Note sur Deux Têtes de Carnassiers Fossiles Ann. des Sc. Nat. 5 ser. tom viii.

[3] Palæontological Memoirs of the late Hugh Falconer. Edit. by Dr. Murchison. Vol. ii.

"The second specimen, labelled No. 2, from the *blue clay and black gravel* beach, Cromer, scoured down after shoot-off cliff, under lighthouse, March, 1860 (Anderson, Cromer).

"This specimen, in a general way, very closely resembles No. 3, just described: like it, the crown is very perfect, and composed of twelve ridges with front and back talons. The grinding surface has extended over the eight anterior ridges. The front ridge is confluent with that of the disc of the anterior talon, which has partly disappeared from pressure. This front disc has the enamel-plate surrounding it somewhat folded, but without crimping; the folds being secondary undulations arising from the confluence of the digitations. . . . .

"This tooth closely resembles that above described; it is somewhat smaller, and belonged to the left side. It does not appear, however, to have belonged to the same individual. The crown discs are somewhat wider and more open, with less appearance of compression, but not to a greater extent than is compatible with individual variation. The specimen agrees, in colour and character of e matrix impacted in the fang interstices, with No. 3. The fresh ory fracture yields the same sepia discoloration; and when burnt gives a strong odour of ammonia (burnt blanket), proving abundice of gelatine. I regard this specimen also as of *E. primigenius*. . .

"Although presenting the ferruginous matrix of the 'Elephantd,' this specimen, like the former, is inferred to have been yielded r one of the superior gravels."

The date 1861 on Mr. Prestwich's specimen proves that this note as written after that year. Dr. Falconer's opinion then clearly was lverse to the Forest Bed age of these two molars of the Mamoth which were not found *in situ* but merely on the beach, and hich therefore do not offer clear and satisfactory evidence of the eposit from which they were derived.

The remains of the Mammoth in the wonderful collection made by e Rev. John Gunn offer still more unsatisfactory evidence of the re-glacial age of the animal. The only case of its occurrence noted by Dr. Falconer is as follows (page 175):—

"In the collection of the Rev. John Gunn, of Irstead, there is a elvis *probably* of *E. primigenius*, which was found at Mundesley in e Elephant-bed under the Paston hill, close to the large os inominatum of *E. meridionalis* already referred to. It is much naller than the corresponding bone of *E. meridionalis*. A comarison of the two exhibits well the gigantic proportions of the tter. The right ilium of *E. primigenius*, where fractured, seems to e highly infiltrated with iron."

It is by no means certain that this pelvis actually belonged to the Iammoth; it might be ascribed with equal justice to the *Elephas ntiquus*, which is very abundant in that locality. A molar in the me collection, referred by Dr. Falconer to an old type of the Iammoth, is merely a beach-specimen, with fragments of matrix orresponding exactly with that upon the Mammoth's tusk dredged p off Yarmouth. There is, then, no evidence to be derived from e Rev. J. Gunn's collection as to the Mammoth having dwelt in 're-glacial Britain. His opinion, indeed, which is of the highest alue, is that all the Mammoth remains are derived from a higher eposit; that they have never been found *in situ* in Pre-glacial beds; nd that he utterly discredits their asserted occurrence in them.[1]

The only remaining evidence to be discussed is that afforded by a ıst upper true molar "of the Pre-glacial variety" from the Norwich oast in the Woodwardian Museum at Cambridge, which Dr. Falconer escribes as follows, page 170:—

"The Woodwardian Museum also contains a superb specimen of the last true molar, upper jaw, left side, of the *Pre-glacial* variety of *E. primigenius* from the Norwich coast. The summit of the crown presents about eighteen discs of wear, of which the most anterior have been ground down to a common base of ivory: the space occupied by fourteen of these ridges is 7½ inches. The enamel is slightly thick, but the plates are transverse and perfectly free from any appearance of crimping. The characters of this specimen diverge widely from the ordinary form of *E. primigenius* in the direction of the Indian elephant, but still maintain all the distinctive marks of true *Elephas primigenius.* The matrix is indisputably of the *forest-bed* of the Norfolk coast, showing in the fangs a greenish gritty sand, full of sulphur, derived from the iron-pyrites so prevalent in the forest-bed."

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[1] "MY DEAR SIR,—I have never found a Mammoth tooth *in situ* in Pre-glacial eds. There is in my collection what Dr. Falconer regarded as an old type of the *Ilephas primigenius*, but it was a beach specimen, and the matrix upon it decidedly orresponds with that upon a Mammoth tusk dredged up off Yarmouth. I have btained a Mammoth tooth from a Post-glacial bed near Bacton, and such specimens ight be expected to fall upon the beach from beds above the Pre-glacial. The 'ichorhine Rhinoceros has not been found in the Norfolk Pre-glacial beds, and *I tterly discredit* the finding of the Mammoth in them."—[illegible] of the tev. J. Gunn to the writer of this notice, dated May 2, 1[illegible]

On consulting Professor Sedgwick, in May, 1867, about this tooth, which was presented to the Museum by Miss Ann Gurney, I find that there is no record of its true gisement. It is clear, therefore, that Dr. Falconer was led to consider it of Pre-glacial age because of its correspondence with what he calls "the Pre-glacial variety of *Elephas primigenius,*" in the collections of the Rev. S. W. King and the Rev. John Gunn, and especially from the character of the matrix. Its agreement with the so-called "Pre-glacial variety" is utterly worthless for the purpose of proving that it is also of Pre-glacial date, because the term itself involves the assumption that a variety of Mammoth lived in Britain during the Forest-bed epoch. We must, therefore, fall back upon the matrix as the only possible guide to the gisement of the remains in the three collections.

On evidence of this kind Dr. Falconer arrived at the belief that the Mammoth dwelt in Europe before the great refrigeration of our climate in the Boulder-clay period. The two molars in the collection of the Rev. S. W. King, which he himself admitted to be doubtful, one pelvis also doubtful, and one molar, picked up on the shore, in the collection of the Rev. John Gunn, together with a second in the Woodwardian Museum, with matrix resembling that of the Forest-bed, led him to infer "that we have unquestionable evidence that the Mammoth existed in England before the deposition of the Boulder-clay, as the contemporary of Mammalian species, handed down from the Pliocene period," and that, therefore, the animal is "entitled to the significant name, proposed by Geoffrey St. Hilaire, in one of the bright inspirations of his latter years, of *Dicyclotherium,* as having by a miracle of Providence survived through two epochs." The premises in my opinion do not in the least degree warrant the inference. On the evidence adduced, the very least that can be said is that the case is not proven.

Nor, indeed, does an appeal to the character of the matrix afford additional probability to the Pre-glacial age of the Mammoth. In the autumn of 1866 the Rev. O. Fisher, F.G.S., and myself discovered in the village of Walton-on-the-Naze a deposit of red pan, or sandy peroxide of iron, derived from the wash of the Red Crag, that is assumed to stamp the Pre-glacial age of remains washed up by the sea on the East coast. In it were firmly embedded sundry waifs and strays, such as fragments of coal, bits of glass, and the like, that show its recent formation. At the present moment as I write I have before me a fragment of a medicine bottle firmly imbedded in matrix that cannot be distinguished from that on the upper and lower jaws of *Rhinoceros Etruscus* found *in situ*, in the Forest-bed of Lowestoft, which are lying by its side. If, therefore, the matrix prove that the Mammoth remains in question were derived from the Forest-bed, it must also establish the fact that glass bottles were used before the deposition of the Boulder-clay. It is clear, therefore, that the peroxidated matrix is no certain guide to the geological horizon. Ever since the Red Crag was saturated with peroxide of iron it must have been the source from which the later deposits in the eastern counties derived their ferruginous character; not only the Forest-bed, but also all other strata deposited by water, that flowed through the Crag area. Since, therefore, the ferruginous matrix is not characteristic of the Forest-bed, as Dr. Falconer supposed, his argument in favour of the Pre-glacial age of the Mammoth falls to the ground. In the present state of our knowledge we must then fall back on M. Lartet's theory of 1858, and view the animal as characteristic of *Post-glacial* times, and as affording a means of differentiating the Pre-glacial from the Post-glacial deposits. It invaded Western Europe along with the Tichorhine Rhinoceros, the Musk Sheep, the Reindeer, and other animals fitted to endure the severity of an arctic winter, occupying the same position in the Post-glacial fauna as *Elephas meridionalis* occupied in that of the Pliocene.

NOTICES OF MEMOIRS.

MR. LOBLEY'S LECTURE ON VESUVIUS.

AT a meeting of the Geologists' Association of London (May 1st) a descriptive account of Mount Vesuvius was given by J. L. Lobley, Esq., F.G.S., who had lately paid a visit to the district and made the ascent of the Crater.

The subject was treated under four heads — 1st, the geographical description of Vesuvius; 2nd, the history of the volcano; 3rd, the geology; and 4th, the ascent to the Crater, with a notice of the phenomena observed during the eruption of the present year.

After an allusion to the situation of Vesuvius with reference to the city and bay of Naples, and to the beautiful scenery of the neighbourhood, to which this bold and picturesque mountain largely contributes, a description of the outline and form of the mountain was given.

Unlike many volcanos Vesuvius is not a simple cone, but a double-peaked mountain, with a widely-spreading, almost circular, base of nearly thirty miles in circumference. One of these peaks forms the highest point of a semi-circular ridge rising on the north and east, and half encircling the modern cone, which towers above the rest of the mountain. The semicircular ridge is called Monte Somma, and is separated from the cone by a deep flat-bottomed valley, to which the name of the Atrio del Cavallo is given. A description of the various parts of the mountain followed, and reference was made to the populousness of the numerous towns and villages lying around the base of the volcano.

The history of Vesuvius is extremely interesting, as it was an active volcano in prehistoric times; then an apparently extinct one, and now, in our own times, it has been, and is still, one of the most active volcanos known.

The eruptions, too, have been attended with the most disastrous results; and, situated as Vesuvius is, near one of the principal cities of Europe, and on the attractive and accessible coast of Italy, they have excited the greatest attention among mankind. The eruption of the year 79 of our era, was the first of which we have any record, for during the whole of the historic period previous to that date, Vesuvius was dormant.

At this period the mountain was a single truncated cone, of great width and comparatively low elevation, with a very large and deep crater.

Strabo was the first to notice that this crater was walled in by rocks, which were igneous and volcanic in character, and he, followed by other early observers, concluded the mountain to be of volcanic origin. The earliest eruption of the historic period, that of 79, resulted in half of the enclosing wall of the great crater being blown away, leaving merely the semi-circular ridge, now called Monte Somma, and a small elevation on the opposite side of the cone, to which the Italians give the name of "La Pedamentina." This terrible outbreak destroyed, as is well known, the three cities of Pompeii, Herculaneum, and Stabia, and quite altered the appearance of the mountain. The death of Pliny the elder, and the account given of the eruption by his nephew, Pliny the younger, in the two celebrated letters to Tacitus, tend also to make this fearful catastrophe a most memorable event in the history of the world. The modern great cone of Vesuvius then began to be formed around the vent of the volcano, and subsequent eruptions accumulated material upon it, until it at length attained a greater elevation than the old summit of the mountain.

Many eruptions, no fewer than fifty-eight, have been recorded since the volcano renewed its activity, all more or less remarkable, but those of 1036, 1631, 1793-4, and 1822, are especially worthy of notice. Of the historic eruptions, those which occurred previous to 1036 do not appear to have produced any fluid lava, and were merely eruptions of ashes, stones, lapilli, and mud, attended with discharges of vapours. In 1036, however, a stream of lava is said to have flowed down the sides of the mountain, and to have reached the sea. The eruption of 1631 is remarkable for the extraordinary quantity of lava which Vesuvius emitted, no fewer than seven great rivers of the fiery fluid having poured down its sides. For several centuries previous to the great outbreak of 1631, the eruptions of the volcano were of little violence, and were separated by long intervals of repose. During this period of comparative rest on the part of

Vesuvius, Monte Nuovo, on the shore of the Bay of Naples, was thrown up. This event took place in 1538, and the phenomenon was of so remarkable a character, that a hill 440 feet high, and more than a mile and a half in circumference, was formed by the accumulation of erupted matter in three days! During the eruption of 1793–4, which lasted upwards of a year, the stream of lava emitted was not even arrested at the sea line, but actually flowed into the sea to a distance of 362 feet, forming a promontory. It was calculated by Breislack that this stream contained upwards of 46,000,000 cubic feet of lava. The eruption of 1822 was by far the greatest outbreak which has occurred during the present century. The modification of the shape of the volcano caused by this eruption was very considerable, since no less than 800 feet of the summit of the cone was blown away, and an immense crater produced, which penetrated to a depth of not less than a thousand feet into the heart of the mountain.

Considering Vesuvius geologically, we find the lower portion of the volcano as far up as the Crocelle, or the ridge on which stands the Observatory, to be of one age, Monte Somma of another, and the great cone more modern than either of the other two portions of the mountain. The formation of the great cone of Vesuvius, as we have seen, dates from A.D. 79, before which time it had no existence. This very interesting part of the volcano is simply the accumulation of the ejectámenta thrown out during the various eruptions of modern times, with interbedded layers of lava, and is consequently made up of a series of beds, or coats, having a quaquaversal dip from a central axis, which is the vent of the volcano, and the mouth of which forms the crater or cup-shaped hollow at the apex of the cone. These beds were found to have a dip of from 26° to 30°, but the exterior slope of the cone has an inclination of 40°. The great eruption of 1822 left so wide and deep a crater that the internal structure of the cone was exposed, and it was then found that dykes of compact basalt crossed the beds of lava and scoriæ, and rose more or less vertically to various heights. These walls of hard rock have doubtless been produced by the filling up of old lava channels and cracks in the cone with liquid lava which has afterwards solidified, and they act as so many ribs, greatly strengthening the structure of the cone. The crater varies in size and shape with almost every eruption, as the greater paroxysmal eruptions tear away the sides of the mouth of the volcano, and leave a very large and deep abyss. This is afterwards rapidly filled up by the accumulation of the lava, ashes, cinders, and lapilli discharged during the minor eruptions which follow, until we find a new cone growing up above the former summit of the mountain, and this has at its apex only a small crater, as is the case at the present time. The central vent is then almost choked, and so it remains until another paroxysmal eruption occurs, when the new cone is blown away, and a great crater again produced.

Monte Somma we find to be a semicircular ridge of about two miles in length, with the face opposite to the cone, forming an almost perpendicular escarpment. This, being a portion of the enclosing wall of the great crater which existed previous to the renewal of the activity of the volcano in 79, is composed entirely of volcanic products. It is not, however, like the walls of the craters of the Phlegræan fields, made up of tuff; but is formed, like the modern cone of Vesuvius, of a series of beds of lava alternating with layers of scoriæ and ashes, and traversed by dykes of compact dolerite. The lavas of the Pre-historic volcano differ considerably from those of modern times, the latter containing little free leucite, and not more than six or seven other minerals; while the lavas of Somma contain a great abundance of leucite, in fine trapezohedral crystals, as well as a large number of associated minerals. The beds of lava and scoriæ composing Monte Somma, overlie the rock of which the whole of the lower portion of the mountain is composed, and which is a soft, straw-coloured, volcanic tuff, similar to the rock so much exposed about the city of Naples, and through which is excavated the great grotto of Posilipo. This is evidently the oldest product of the volcano, and has, doubtless, in part at least, been deposited under water, from the fact of several species of marine Mollusca having been found in the tuff of this neighbourhood. The fundamental rock of the district is the Apennine limestone, which is of Cretaceous age, and on this the whole mountain reposes.

Resina, one of the populous towns at the foot of the mountain, and on the shore of the bay, is the usual starting place when the ascent of the mountain is made. This town is built upon the lava of 1631, which overlies the bed of tuff in which Herculaneum is entombed. After leaving Resina, the path traverses highly cultivated and very fertile vineyards and gardens, in which the famous wine "Lachryma Christi" is produced. The land owes its great fertility to the felspathic matter derived from the decomposition of the underlying lavas. After ascending gradually for about two miles, the lava of 1858 is reached, and the scene is entirely changed; for from this point to the summit there is not a trace of vegetation.

The appearance of the surface is very extraordinary, from the grotesque and varied forms the lava has assumed in cooling. The colour of the recent lavas is, in some places, black; in others, a dark brown; and the surface is exceedingly rough and difficult to walk over. The ridge of the Crocelle rises out of this sea of lava, and on its summit stand the Hermitage and Observatory.

From the Crocelle the observer looks over that part of the mountain down which the red hot lava flowed during the recent eruption. The lava of this year, it appears, issued from the top of the old cone, and descended its side for some time in a splendid fiery stream; but this stream becoming covered, by cooling, with a crust of hardened lava, the fluid was not seen until it had reached the base of the cone, when it came to the surface, issuing in small streams at various points. These streams run slowly and noiselessly along, losing their brightness very quickly, soon becoming covered with scoriæ, and, after flowing about a hundred yards, losing their fluidity and breaking up into cindery masses, which form ridges not unlike unfinished railway embankments. After passing the Hermitage and Observatory and traversing the Crocelle, the path enters the Atrio del Cavallo, from which the ascent of the cone is made. As the inclination of the sides of the cone is 40°, and the surface covered with loose masses of scoriæ of all sizes, this is the most difficult and laborious part of the whole ascent. Perseverance, however, lands the traveller at length on the top of the old cone, where he finds himself on a narrow terrace surrounding the base of the small cone, formed during the recent eruption. This new cone is found to be about two hundred feet high, with sides comparatively smooth, the upper part being covered with beautifully and variously coloured incrustations, the sublimates of the volcano. Sulphur was very abundant, and sulphate of copper, from its bright blue colour, very conspicuous. Great quantities of vapour rise from the surface of the new cone, and these fumes become so dense at the summit as almost to conceal the edge of the crater. At the time of the lecturer's visit, in March, 1868, scoriæ and ashes were being shot forth to a great height from the crater, with loud explosions and rattling subterranean noises. The interior of the crater had a very wild and extraordinary aspect, and formed a striking contrast to the bright and peaceful scene presented to the eye when turned in the opposite direction; for, from the summit of Vesuvius, a grand panoramic view is obtained of the scenery around the world-famed Bay of Naples, which, once seen, is never to be forgotten.

REVIEWS.

I.—MAN'S ORIGIN AND DESTINY SKETCHED FROM THE PLATFORM OF THE SCIENCES (being a course of Lectures delivered before the Lowell Institute in Boston, 1865-6). By J. P. LESLEY, Memb. National Acad. U.S., and Sec. American Phil. Soc. 8vo. pp. 384. London: N. Trübner and Co. 1868.

THIS course of lectures, though not entirely, or even largely, geological, yet contains many references to the method of geological investigation, and many descriptions of geological facts bearing on the question of the Origin of Man. These features we gladly seize upon, and invest with perhaps too great importance, as an excuse for reviewing, in a purely geological publication, a book so calculated to interest every intelligent man.

Mr. Lesley adopts the safe plan of giving his hearers some preliminary knowledge of "the sciences," from whose "platform" he intends to sketch "Man's Origin and Destiny;" and to avoid an evil of great importance and very common occurrence, viz., giving undue weight to one particular branch of knowledge at the expense of others, he exhibits a classification of the sciences in a scheme designed to show their individual scope and mutual relations. As this scheme is in some respects peculiar we subjoin it for our readers' consideration.

CLASSIFICATION OF THE SCIENCES.

I. GENERAL SCIENCES:—1. Philosophy. 2. Bibliography.

II. MATHEMATICAL SCIENCES:—1. Mathematics. 2. Astronomy. 3. Meteorology. 4. Geodesy. 5. Geography. 6. Physics, leading to the

III. Inorganic Sciences:—1. Chemistry. 2. Mineralogy. 3. Metallurgy. 4. Geology. 5. Palæontology, leading to the

IV. Organic Sciences:—1. Biology. 2. Botany. 3. Zoology. 4. Medicine, leading to the group of the

V. Historical Sciences:—1. Chronology. 2. Mythology. 3. Archæology. 4. Ethnology. 5. History, leading to the

VI. Social Sciences:—1. Sociology or Statistics. 2. Manufacture. 3. Commerce. 4. Defence. 5. Equity, leading to the

VII. Intellectual Sciences:—1. Language. 2. Belles Lettres. 3. Fine Arts. 4. Metaphysics. 5. Education. 6. Philanthrophy. 7. Worship.

VIII. Personal Science:—1. Biography.

A perusal of the first lecture reveals to us Mr. Lesley's high qualifications as a teacher. His "way of putting things" is so apt, and so likely to remain impressed on the memory. The growth of sciences, for example, is described as analogous to that of empires. "Their boundaries shift. Smaller states are absorbed into kingdoms. On the other hand, empires which have been indiscreetly enlarged by an agglomeration of hostile or unsympathizing nationalities, fall asunder, and out of the *débris* are instituted separate and almost independent *régimes*."

Mr. Lesley quotes "Geology as illustrating both these tendencies," in the following passage (p. 4):—

"At first it was like one of those wild tribes of Germany that conquered the Roman empire. It was a rude, undisciplined study of a few of the most prominent features of the ground. But gathering strength as it developed the observing faculties, and emancipating itself from its aboriginal superstition of the *Lusus Naturæ*, adopting the purer faith in cause and effect, it conquered and subjugated, one by one, all the other branches of human knowledge. The dukes of this new Burgundy outshone and outweighed their liege lords—kings and emperors. Its later princes—Von Buch, De Beaumont, Murchison, and Lyell formed a splendid dynasty. The wealth of the whole world of science flowed into its public treasury. They were even not afraid to wage war against the world of metaphysics, and it seemed as though Church as well as State would be absorbed into one great, upstart, irresponsible despotism."

These extracts will give an idea of Mr. Lesley's style, and of his mode of treating the subjects of his lectures. We must now give a brief sketch of his book.

Contrasting the genius and the method of the ancient sciences with those of the modern, he brings out prominently the childish, fanciful, credulous, and purposeless character of the former, in contrast to the practical, critical, and comprehensive nature of the latter. He sums up the whole distinction of method in one sentence, by saying that modern sciences replace fancy by experiment, though perhaps investigation would have been a more comprehensive and accurate term.

The "Antiquity of Man" is a theme upon which Mr. Lesley has naturally much to say; and extremely well he places before an unscientific audience the facts upon which we now rely as proofs of the ancient date of man's first appearance on the earth. Not content, however, with a bare statement of these facts, our author gives a lucid history of the circumstances which, one by one, led to an acknowledgement of the true meaning of the discoveries which had been made from time to time during the last forty years, after they had been successively smothered, doubted, or explained away by the advocates of the once omnipotent "Diluvial" theory.

The antiquity of man being now taken as accepted, it furnishes Mr. Lesley with a new starting point, and at once suggests the question, what manner of men were they who made the flint implements? Therefore, in his fourth lecture, entitled "On the Dignity of Mankind," he discusses the origin of species from the opposing standpoints of Darwin and Agassiz, and more especially the relation of man to the lower animals. He thus leads his readers, as he led his hearers, through the stages of the old controversy which we, in England, have heard so often. Our author's own conclusion seems to be that, so far as natural science can guide us, the differences between man and the higher apes are but differences of degree, but he adds that the imperfection of our data, and the mystery attaching to the functions of the brain, should make us temperate in entertaining convictions on the subject.

"The Unity of Mankind," the subject of the next lecture, is cognate to the last, and it is with no surprise that we read the author's inference as addressed to a Boston audience. We will let him speak for himself:—"I account it probable, then, that the races of mankind have always been distinct; and that they probably made their appearance on the planet successively; perhaps the black and meagre races first, and the white races last. It would not be strange also to find their history running parallel with that of the apes and monkeys."

We must pass by Mr. Lesley's well-told history of the early social life of man, and his discussion of language as a test of race, merely recording our assent to his negation of the theory that it can be so used, and proceed to give a sketch of the author's apparently favourite idea of what he terms Arkite Symbolism. This theory "starts from a given point, the already established worship of the mountain, ship, and flood, without explaining how this worship was begotten; only denying that it was developed intellectually out of Fetichism, Ophism, Mithraism, Phallism, or any other known mythology; and affirming, on the contrary, that it explains and embraces them." This is the author's concluding sentence; and it probably gives as lucid an idea of his theory as any description of our own. However, let us retrace our steps for a moment to his lecture on the Origin of Architecture, and see what assistance that will give us. The simplest and oldest example of architecture is seen in the sepulchral mount. The tumulus passes onwards into the pyramid, then the propylon of the Egyptian temple, then the pagoda, and so forth. Now Mr. Lesley, although admitting that caves, basaltic columns, forests, and so forth, may have suggested at different periods certain points of detail, considers that "they offer no sufficiently broad explanation for the great mystery of its original conception in the human mind." He cites various temples,—Egyptian, Hindu, Norwegian, &c.,—as consisting of two chief members, the lower being a square pyramid, the upper an overhanging box; the former represents Ararat, the latter the ark that rested on its summit. By and by there arose in Egypt a duplicated type of temple, symbolizing two mountains side by side, each with an ark on its summit. The Christian cathedrals, also, according to Mr. Lesley, were built upon this plan, with the difference that a single ark (or nave) was placed *between* the two mountains (or towers). What is the meaning of this? Why, that the summit of Ararat consists of two cones, between which it is supposed that the Ark rested. In the same manner we have the origin of the the obelisk, the column, and so forth. The Doric column, however, carries the symbolism still further; for it "is channelled like a mountain with valleys."

Similarly the discussion of the origin of the alphabet furnishes a number of examples of the dominant Arkite mythology, the letter A being essentially nothing but a pyramid. In fine, according to Mr. Lesley, the beginning of everything is Arkite.

He refers all forms of religious worship to one or another of four types, namely (1), the worship of the dead; (2), the worship of the powers of nature; (3), the worship of God in heaven; and (4), the worship of the universe. He regards these as four successive stages in the order of the development of the human intelligence governing the exercise of the instinct of worship; and not only philosophically consecutive in the order of nature, but to a certain extent also historically consecutive in the order of time. He states, however, that in some ages they have co-existed, and in some countries have been intermixed.

For evidence of the worship of the dead Mr. Lesley refers to the Aurignac cave, to the Druidical dolmens, cromlechs, and other grave structures. The worship of the powers of nature he describes as being in its lowest form Fetichism, and in its higher forms astrology and fire-worship. The description of the third type of religion—"the worship of the invisible God as a creator, preserver, benefactor, and judge,"—leads him to the question how this original conception was generated in the soul of man. He discusses the manifestation of this idea as preserved in the Biblical record from the time of Abraham, and in the hymns of the Rig Veda.

The highest type of the religious idea Mr. Lesley holds to be Pantheism, the philosophic idea of God; but he regards it impossible that this form of religion should ever become universal.

The third type of religious worship is of course a fruitful source of discussion and controversy. Its origin, the primary connection of its numerous varieties, the mythologies and the cosmogonies, are subjects which have been discussed by able writers of all ages and all civilised nations. Mr. Lesley rejects the common explanations as possessing no system and no basis; and he finds the "safe clue to the labyrinth" in his universal Arkite symbolism. This talisman explains the origin, not only of the alphabet and of architecture, but it unriddles the sphinx and all the symbols and hieroglyphics of Egypt and Asia. Indeed, he states that just as the seven notes of music have furnished to composers the material of their melodies and harmonies, so have the three elements of Arkite symbolism—the ark, the mountain, and the flood—yielded the fundamental idea which is embodied in the numberless myths, monuments, symbols, and inscriptions of ancient civilization.

It is quite possible that the symbols of the ark, mountain, and flood are portrayed in some of the instances quoted by Mr. Lesley, as, indeed, other investigators have pointed out likewise; but every man has his own particular hobby, Mr. Lesley's being Arkite Symbolism.

We cannot conclude this notice without expressing our thanks to the author for supplying us with so readable a book; and we hope it may not be long before a new edition is called for; which will furnish us with another opportunity of improving our acquaintance with so agreeable a fellow-traveller, writer, and lecturer.

II.—ACADIAN GEOLOGY.—THE GEOLOGICAL STRUCTURE, ORGANIC REMAINS, AND MINERAL RESOURCES OF NOVA SCOTIA, NEW BRUNSWICK, AND PRINCE EDWARD ISLAND. By JOHN WILLIAM DAWSON, M.A., LL.D., F.R.S., etc., etc. Second edition. London: Macmillan and Co. 1868. 8vo. pp. 694.

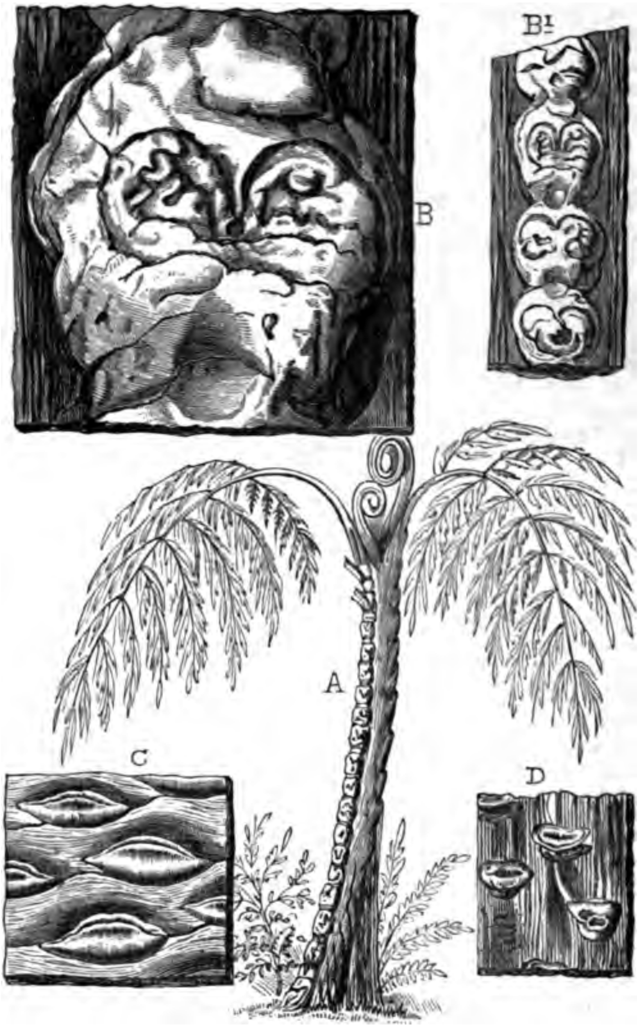
THIRTEEN years have passed since the first edition of this work was published. During that interval its distinguished author has been diligently and successfully prosecuting his investigations in Acadian geology. He has issued numerous memoirs, in British and American journals, on the physical structure of the region which he has made so completely his own, and on the organic remains discovered there—memoirs which have not only elucidated the geological history of Acadia, but have largely contributed to a just appreciation of the physical and biological conditions of the palæozoic epoch in other regions of the earth. These various memoirs, along with observations hitherto unpublished, are digested and incorporated with what was published in 1855, producing a volume very imperfectly characterized on its title-page as a "second edition, revised and enlarged," inasmuch as it contains about five times more matter than the original work. It would be, as is evident, a vain undertaking to endeavour to present to the reader an acount of the additions contained in this edition; we shall examine at greater length the important exposition of the Palæozoic flora, first glancing only at one or two other points of importance.

The earlier chapters on the Boulder-clay and subsequent deposits have a special interest at present. The chapter on the Micmac Indians, and the results produced by forest fires, abound with observations which must receive the careful consideration of those in Europe who are investigating the question of the antiquity of man. We have a long historic period in Europe, the earlier portions of which, in those districts where investigations as to man's antiquity have been carried on, are very obscure and mythical, while the prehistoric period is, as regards the measurement of time, utterly without any certain indications. Successions of events can be determined satisfactorily, but estimates of the time required for their occurrence are of necessity purely hypothetical. Any help to the discovery of a trustworthy time-measurer would be of great service. In the history of the Micmacs and in the succession of forests, in the same localities, resulting from natural causes, and within a known time, Principal Dawson believes that he has data for maintaining that a much shorter period was required for the ethnological and phytological changes in Denmark and other places than is generally demanded by antiquarians.

The Glacial phenomena, with the associated drift, are ascribed to the action of the sea and its currents bearing ice at certain seasons of the year, accompanied with a gradual subsidence and re-elevation of the land, while the action of Glaciers was very subsidiary. Considerable confusion has arisen from generalizing on the origin of Boulder-clays from observations made in circumscribed localities. The Boulder-clays of the South of England differ, as is well-known, from those of Scotland. They contain boulders from distant localities, associated with some obtained from neighbouring rocks, while in Scotland the deposits are local, all the boulders being derived from higher portions of the water-system in which they occur, and the clay itself deriving its colour from the predominant rocks of the district where it occurs, and from which it was derived. The local glacier will alone account for the Scottish Boulder-clay, while the phenomena of the English deposit requires the floating iceberg. It is quite evident that the Acadian Boulder-clays agree more with those of the South of England; but while arguing for their oceanic origin, Dr. Dawson must admit the local glacier origin of other deposits.

We must pass over the tempting record of the discovery of the land animals of the Devonian and Carboniferous periods, and the interesting account given of this singular fauna, which have been unearthed first and chiefly in Acadia, and by the labours of Principal Dawson; but we must especially notice the important observations he has made on the Flora of these periods. The learned author has devoted his special attention to the investigation of this vegetation which has left so large a record in the earth's crust. He has greatly added to the number of known species, he has examined into the conditions of the accumulation of coal, and determined the various microscopic structures which are met with in the coal itself. And now he proceeds a stage further, and re-uniting the broken and scattered fragments of the plants, he builds up in a series of restorations what appears to him to have been the aspect of the living plant. In the animal kingdom the work of restoration depends more on observation than on imagination, as the different parts of an organism bear a tolerably definite proportion and relation to each other; but in the vegetable kingdom, on the other hand, imagination must be the chief source of restoration where the preserved materials are few and imperfect, as no relationship exists between the size of the fruit, the flower, or the leaf, and the branch, the trunk, or the root. A careful comparison of the various organisms and structures preserved together may check the imagination, and cautious inductions on their affinities may come very near to a de-

FIG. 1.



A. *Megaphyton magnificum*, Dawson, restored.[1]
B. Leaf-scar of the same, two-thirds nat. size.
B.¹ Row of Leaf-scars, reduced.
C. *Palæopteris Harttii*, Dawson, scars half nat. size.
D. *Palæopteris Acadic*, Dawsona, scars half nat. size.

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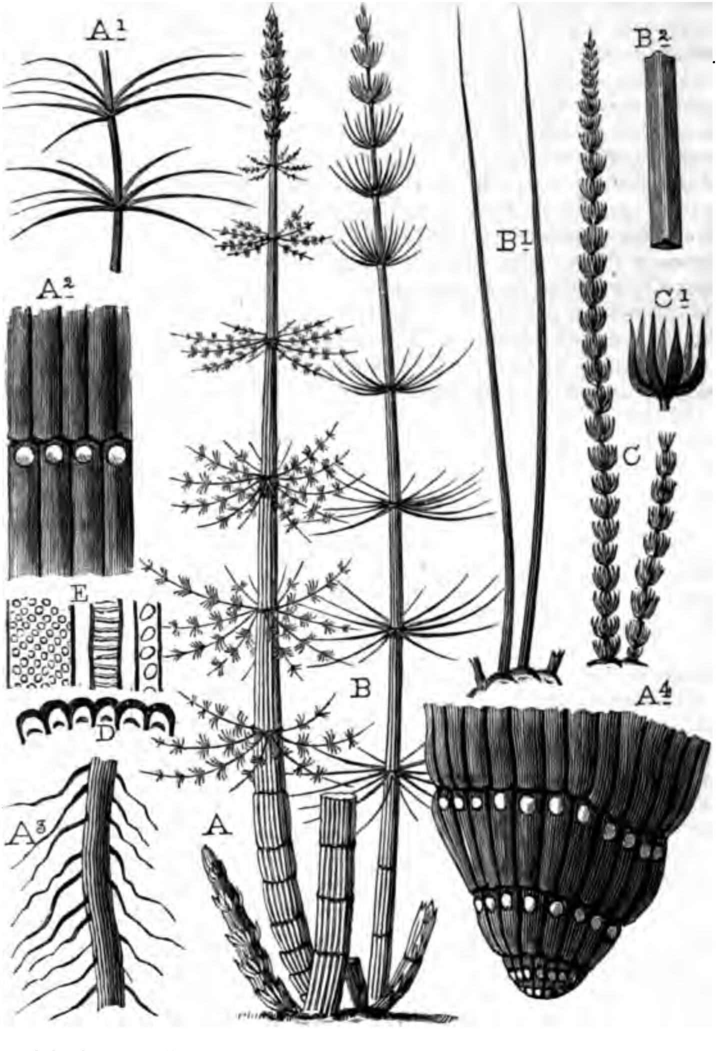
[1] We are indebted to the publishers of the "Acadian Geology" for the use of this and the three other woodcuts from that work.

monstration of their relations; but the only method of determining with certainty the different parts of a vegetable organism is the discovery of these parts in organic connection. Thus in *Sigillaria*, as long as we know that it had a long fluted and scarred trunk and stigmaria root, and only this, we may restore it as a simple, dichotomous branching, or irregularly and repeatedly branching stem covered with small, long, or fern-like leaves; and each of these, as far as the materials over which our restoration is based, with equal accuracy.

The most curious restoration in the volume is that of *Megaphyton*. (Fig. 1) of which genus all that we know is that it had a large trunk with two opposite rows of large reniform or oval scars and numerous smaller scars covering the rest of the stem. This Dr. Dawson restores as a tree-fern bearing opposite pairs of enormous fronds. We cannot understand how the vascular tissue was developed to form so large a stem when the leaves were far removed on the opposite surfaces, and their bases not amplexicaul. So opposed is this to what is known in any recent plant that we prefer, with M. Ad. Brongniart, to consider the large scars as produced by branches, by peduncles, or by adventitious roots, rather than by leaves, and to place *Megaphyton* along with *Ulodendron* as an ally of *Lepidodendron*.

In the restoration of *Calamites* we believe there is reason for going further than is done in Fig. 2. The structure and arrangement of the fruit and the foliage in *Asterophyllites*, *Annularia*, and *Sphenophyllum* are the same. Their remains are associated with those of *Calamodendron*, and when the structure of the stem is preserved it is found to be the same as that of this genus. Dr. Dawson has himself observed this, for in speaking of *Asterophyllites*, he says that they had a "stout internal woody cylinder, in which respect they resembled miniature *Calamodendra*." The ribs on the stems were internal in the branches known as *Asterophyllites* just as in *Calamodendron*. The vascular bundles were parallel in the internodes, but interlaced at the nodes as in *Equisetum*, and the whorl of scars (A^3 and A^4) associated with the interlacings at the nodes represent the opening of the meshes through which the vascular bundles passed to the whorl of leaves or branches produced at the nodes. Nothing is known of *Calamodendron* by those who retain it as a distinct genus, but that it was a stem; associated with it are these branches, leaves, and fruit, which agree in structure with it—and that they actually belonged to it can scarcely we think be doubted. The fruit was certainly that of a cryptogam belonging to the Order *Equisetaceæ*—but to this is opposed the statement that disc-bearing tissue characteristic of gymnosperms enters into the composition of the stem of *Calamodendron*. We have carefully examined several beautiful stems belonging to Mr. Binney, and a large series of our own from the Ash-bed in Arran, but have failed to detect any disc-bearing tissue. The whole vascular portion of the stem is made up of scalariform tissue, as in the larger number of vascular cryptogams, but differing in this respect remarkably from the recent *Equisetaceæ* It would greatly add to the value of Dr. Dawson's restorations and of one's estimate of the systematic position of the plants he is dealing with if it were obvious how far the structure he ascribes to them had been found by him in sliced sections of prepared specimens of the

Fig. 2.



A. *Calamites Suckovii*, Brongn., restored.
A^1. Foliage.
A^2. Ribs and scars.
A^3. Roots.
A^4. Base of stem.
B. *Calamites Cistii*, Brongn., restored.
B^1. Leaves.
B^2. Leaf enlarged.
C. Leaves of *C. nodosus*, Schloth.
C^1. Whorl enlarged.
D. Structure of stem.
E. Vessels magnified.

stems themselves, which could without doubt be referred by their external characters to a particular genus.

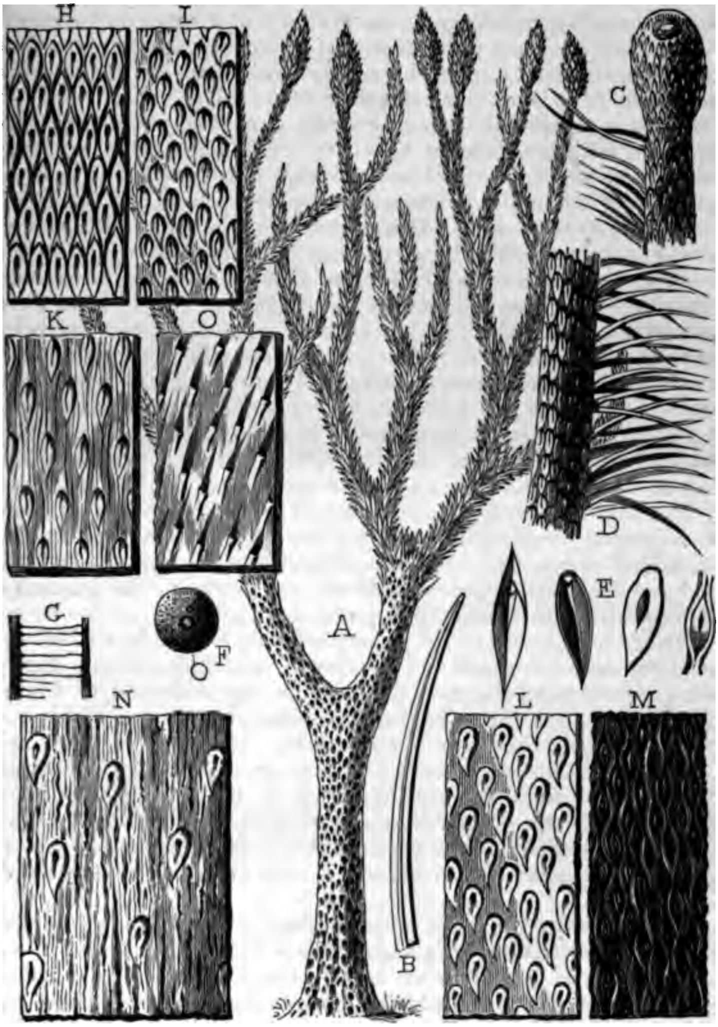
The beautiful specimens of *Calamites nodosus*, Schloth., figured by Lindley and Hutton, belonged to a repeatedly branching plant, and were not simple plants as represented at C, Fig. 2; an examination of the original specimens now deposited in the Newcastle Museum shows that the form to which they gave this name are really the branched fruiting spikes, and not the true foliage of *Calamites.*

Our own observations in regard to the structure of these plants differ so much from those of Dr. Dawson that we are compelled to modify somewhat the systematic position he gives to *Sigillaria* as well as to *Calamodendron.* It is remarkable that so little is known of a genus of plants which are so abundant in Carboniferous strata, and the more so that every particular is known regarding the structure of its associated genus *Lepidodendron.* Dr. Dawson has ample authority for his restoration of his *L. corrugatum* (Fig. 3) as far as it goes. The sporangium may have been of a different form, and only one connected with each scale, as in *Lepidostrobus;* but otherwise there can be no hesitation in co-relating all the other parts. The author has done good work in tracing the different forms of scars, which without persevering research would have been, by a more hasty and careless worker, referred to several distinct species. That *Lepidodendron* belongs to the vascular cryptogams, and had the habit of, if it did not belong to the Order of *Lycopodiaceæ* every one acknowledges. And that in all characters in which they can be compared—except the microscopic structure of the vascular axis of the stem—these two genera were closely allied is also generally admitted—indeed it is very difficult in many cases to determine to which of the genera some species should be referred, and no characters can be drawn which will suffice to distinguish the *Favularia* group of *Sigillaria* from the group of *Lepidodendron* to which Dr. Dawson applies the name *Lepidophloios.*

The characters derived from the internal structure of the stem are those upon which the two groups are separated into genera, and by some authors placed widely apart systematically. Brongniart's admirable memoir on the structure of *Sigillaria elegans* is still the most complete exposition of the subject. He describes it as consisting of a cellular axis surrounded by a double cylinder of vascular tissue, the inner consisting of distinct bundles of a lunate form and the outer regularly arranged in radiating series, sometimes broken up by narrow radiating intervals supposed to have been occupied by medullary rays. Beyond the vascular cylinder was a cellular layer, becoming more dense towards the circumference, and traversed by the vascular bundles which passed out to the leaves. This description agrees with the figure given by Dr. Dawson (Fig. 4, C), except that Brongniart saw no indication of diaphragms (*a*) in the cellular axis, or of a cylinder of disc-bearing tissue (*b*); and also with the section of (*Lepidodendron*) *Lepidophloios Acadianus* (Acadian Geology, p. 457, fig. I).

Dr. Hooker, in his Essay on the Carboniferous Flora, doubts whether the appearance in the fossil which Brongniart considers as representing medullary rays are really so or not. The relation of

Fig. 3.



A. *Lepidodendron corrugatum*, Dawson, restored.
B. Leaf, nat. size.
C. Cone and branch.
D. Branch and leaves.
E. Various forms of leaf areoles.
F. Sporangium.
G. Scalariform vessel, magnified.
H. I, K, L, M. Bark with leaf-scars.
N. Ditto of old stem.
O. Decorticated stem (*Knorria*).

these so-called medullary rays to the vascular axis and to the separate internal vascular bundles, together with the entire absence of any indication of the cellular structure of the medullary ray in radial sections, put it, in our estimation, beyond a doubt that they cannot be considered as medullary rays. We have never met with a specimen of *Sigillaria* in which the woody cylinder was preserved, but we have examined a large series of *Stigmariæ* in which the vascular tissue was in a good state of preservation. The vascular axis of *Stigmaria* is certainly composed entirely of scalariform vessels, perfectly free from medullary rays, but traversed in an upward and outward direction by vascular bundles which pass from the interior of the cylinder through the meshes made by the opening and closing of the vascular tissue.[1] So far this agrees with what was observed and figured by Brongniart in the stem of *Sigillaria elegans*, with Binney's *Sigillaria vascularis*, with Lindley and Hutton's *Lepidodendron Harcourtii*, and with several specimens of *Lepidodendron* which we have examined. If true disc-bearing gymnospermatous tissue has been found *in situ* forming an outer layer surrounding the scalariform tissue, the notions hitherto entertained regarding the systematic position of this genus deduced from the structure of the stem will be greatly modified. But its absence in those exquisitely preserved stems of which drawings and descriptions have been published, as well as in *Stigmaria*, the undoubted roots of *Sigillaria*, makes us hesitate to refer such tissue found in coal to this genus, and set aside any argument based upon this to place *Sigillaria* as high in the vegetable kingdom as the Gymnosperms. No argument can be built upon the supposed fruits of *Sigillaria*, for, as yet, no one has found them so related as to make their connection probable.

The only Gymnosperm in Principal Dawson's list is, we believe, the genus *Dadoxylon*, and it is worthy of remark that if complexity in the structure of the medullary ray be any indication of higher organisation, then these Palæozoic conifers were more highly organised than any that have followed them.

To conclude, the evidence before us is greatly in favour of reducing *Sigillaria* from the Gymnosperms to the neighbourhood of *Lepidodendron* among the vascular cryptogams, and of placing *Megaphyton* beside them rather than among the ferns, and of reducing also *Calamodendron* and uniting it with *Calamites* as a genus of *Equisetaceæ*.

While differing in these respects from the conclusions of Dr. Dawson, it requires only a glance at the work by a student of these ancient forms of vegetable life to perceive that there is here one of the most important of modern contributions to the science of palæontological botany.

W. Carruthers.

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[1] We write this remembering that Cotta has figured a longitudinal section of *Stigmaria ficoides*, the vascular tissue of which is composed of Cycadean-like vessels traversed by the muriform cells of medullary rays, but it is quite certain that if this is a faithful representation of the wood of the fossil, the fossil is not *Stigmaria ficoides*.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—May 6th, 1868.—"On the Quaternary Gravels of England." By Alfred Tylor, Esq., F.L.S., F.G.S. Mr Tylor first compared, by means of sections and models, the gravels of the Aire Valley at Bingley, of the Taff Vale between Quakers' Yard Junction and Aberdeen Junction, and of the Valley of the Rhonda near its junction with the Taff. He then described the cave-section of Bacon Hole, Gower, and the sections exposed at Crayford, Erith, and Salisbury, comparing the angles of deposition of gravel-beds concealing the escarpment of the Chalk in these last three localities with the same conditions at Brighton and Sangatte.

By comparing the gravel-beds at different levels, and upon strata of different age and configuration, he showed in what respect they differ from each other. The bulk and height of the Quaternary deposits had strengthened the conviction which he expressed in his previous paper (on the Amiens gravel), that there was a long period, reaching nearly to the Historical epoch, in which the rainfall was excessive, and which he termed the "Pluvial period."

These sections also led the author to the following conclusions:—(1) That the débris was deposited by land-floods, and that the mode of deposition was quite distinct from that of moraines produced by the melting of ice. (2) That the character of the deposits in the valleys of the Aire, Taff, and Rhonda proves that they were formed under similar conditions. (3) That these gravel-beds point to a Pluvial period of great intensity and duration. (4) That the ice-action of which there is evidence was subordinate to the aqueous action. (5) That the fossiliferous Quaternary deposits have been best preserved where they have been formed in cavities lying between the edge of the bank of a river, estuary, or sea, and an escarpment running parallel with it at no great distance, (6) That the immediate source of the gravels was the high land adjoining the rivers, whence they had been washed down by rain, with the assistance of lateral streams, into the lower ground, where they had come into contact with larger quantities of running water, had been mixed with rolled materials, and spread in thick beds over the bottoms and slopes of valleys or the sides of escarpments. (7) That the surface of such a deposit rarely slopes at more than 2° or 4°, while the slope of the beds lower in the series near the escarpment averages 12°. The escarpment is usually concealed under a coating of gravel or loess.

DISCUSSION.—Mr. Prestwich dissented from the view of the author, that the valleys had been excavated to their present depth before the gravels were deposited; and, with reference to a former paper, explained that Mr. Tylor and himself had taken different points of observation near Montiers, and that his own views as to the separation, which in some cases may be shown to exist betwen the high and low level gravels, were correct.

Mr. Evans also combated Mr. Tylor's views, and pointed out the difficulty of accounting for deposits of gravel such as are at present found in valleys already excavated to their present depth.

Mr. W. Boyd Dawkins objected to calling in hypothetical causes to account for effects when existing causes are sufficient, and cited the sudden melting of snow as a sufficient cause, as had already been suggested by Mr. Prestwich.

Sir Charles Lyell supported the same view, and mentioned a case which had occurred at Salisbury some few years ago as an instance of the effects of such floods. He also cited the existence of flint implements in the gravels on either side of Southampton Water as evidence of the existence of man during a long period of excavation of valleys. He also mentioned the discovery by Dr. Harris of flint gravel identical with that of the present valleys beneath the Basalt of Miocene date in Antrim.

Mr. Searles V. Wood, Jun., insisted on the impossibility of even an enormously increasing rainfall filling the valleys as suggested by Mr. Tylor, and pointed out the influence which such an accession of fresh water must have had on the animal life in the estuaries. He also mentioned tidal action as an excavating agent in valleys.

Prof. Ansted showed, by calculation, that even a vast increase in the rainfall would not suffice to fill the valleys so as to deposit the gravels as at present found.

Mr. Whitaker quoted the existence of distinct terraces of gravel one above the other in the Thames Valley as proving the gradual excavation of the valley.

Prof. Morris doubted as to the precise character and age of the deposits in the valleys in South Wales having been accurately ascertained.

Prof. Ramsay made some concluding remarks (as President), expressing his disagreement with the views of the author as to the enormous magnitude of the ancient rivers.

CORRESPONDENCE.

ON THE CAUSE OF CONTORTIONS, FAULTS, AND DISLOCATIONS IN THE CRUST OF THE EARTH.

Sir,—I observe from several recent articles in the Geological Magazine, as, for example, the paper of Mr. Wilson in your May number (p. 205), and the letter of Mr. Maw in that for this month (p. 294), that the attention of geologists is being directed to the mechanical effects of upheaval or depression acting on extensive portions of the rocky crust of the earth. May I be allowed to ask the consideration of those who may be engaged in such inquiries to certain passages relating to this subject to be found in my volume on Volcanos, which may not have fallen under their observation? I refer especially to pages 46–52 (edit. Longman, 1862), in which it is suggested that whether the disturbing force be elevation or depression (arising from whatever cause), there must exist a centre, or central axis, of dislocation, where the disturbing force will be at its maximum, and also some lateral limits beyond which it does not operate; and that the effect produced on the mass of rock included within these limits must be similar to "that which is known to be produced in a beam fixed at either end, and broken by upward pressure at its centre, namely, a compression which takes effect in the central part *beneath*, and in the lateral parts adjoining the fixed extremities *above* a neutral line or 'pivot axis;' while, on the other hand, the upper portion of the central parts and the lower strata of the lateral parts will be subjected to a tearing strain." The resulting effect of such dislocating forces on rocks of so rigid and coherent a character as to break rather than bend, or yield like a liquid or pasty mass under pressure, would be to cause rents at right angles to the direction of the dislocating force and "gaping," *i.e.* widening upwards, in the case of an elevatory action about the centre and downwards about the lateral portions, and *vice versâ*, of course, in the case of a depressing action. If any of these rents opened so far downwards as to reach a mass of matter liquefied by heat, or at such a temperature as to be more or less liquefied by the reduction of pressure to which under such circumstances it would be exposed, the result would be the suction or pumping up of such liquefied or pasty matter into the fissures, and should any of these reach the outer atmosphere, its explosive eruption on those points. While, on the other hand, in the portions subjected to compression the result would be the contortion and outward bulging of such masses of rock as were pliable, and the dislocation and outward shoving of wedge-shaped portions of such rocks as were too rigid to yield otherwise, much "as we see wedge-shaped chips split off and forced outwards from the edges of a crack formed in the same relative position through a rigid mass of stone or metal broken across by pressure" (p. 54, *op. cit*).

I will not occupy more space in your pages by an extension of these quotations. But your readers will, I think, admit that these considerations may serve to throw some light on the questions relating to the probable origin of the fissures, faults, veins, dykes, contortions, and other obvious displacements of superficial rocks, to which Mr. Maw's and Mr. Wilson's observations refer. In the work above cited I have ventured to carry still further the speculations they suggest, by hazarding the supposition that, when repeated, elevatory movements have operated through a long time over very wide areas, the result may be seen along the central axes of dislocation in some of the chief mountain ranges of our continents, while distant parallel lines of volcanic development mark the horizontal limits of disturbance on one or both sides, where the production of rents gaping downwards may have allowed the heated subterranean matter to force its way up towards, or actually to the subaërial surface. These last speculations must go for what they are worth. But the mechanical theory on which they rest can hardly, I think, be disputed. It differs in some respects (as I have shown in Volcanos, p. 51) from those of Mr. Hopkins and Mr. Darwin, but rather in the terms of the question, that is, the supposed circumstances, than in its solution. With regard to outward bulging or contortion, accompanied as it must be by movement and friction, *inter se* of the particles, should they be capable of movement, being the cause of slaty cleavage, I have always agreed with the late Mr. D. Sharpe, and have myself more than once suggested to geologists, but as yet, I fear, without much success, that the laminar structure of the metamorphic[*] schists is owing to the same cause—gneiss being only a *squeezed granite.*

G. Poulett Scrope.

Fairlawn, Cobham, Surrey, *June 5*, 1868.

ON FAULTS AND CONTORTIONS IN STRATA.

Sir,—I read with considerable interest a short paper in your May number, by Mr. J. M. Wilson, attempting to explain the causes by which contortions and faults are produced. Mr. Wilson's theory, that "contortions are the inevitable result of the depression," and "faults of the elevation of a curved surface," from its soundness and simplicity is likely to be generally accepted; at the same time I do not think that all faults or contortions can be ascribed to the operation of one universal cause. In the first place, if such were the case, should we, according to Mr. Wilson's view, *ever* find that the direction of the fault hades (underlies) in the direction of the *up*throw? Such cases do occur, though they are exceptional. Secondly, according to Mr. Wilson's theory of faulting, the elevation of a very extensive area of the earth's surface is necessary for the production of a complete series of upthrows and downthrows, as shown in Fig. 4, p. 207, Geological Magazine. Now I have lately met with such a series in a horizontal line, 136½ feet long, in the Upper Red Marls of the Keuper Series, Nottingham. It occurs on the brow of the hill near the Mapperley Reservoir, and is well shown in a road cutting. I enclose a rough sketch of the section. I think there can be no doubt that the cause which produced that faulting acted locally, and if that cause were the elevation of a curved surface (which perhaps may have been the case), that curved surface was not due to the curvature of the earth's surface, for over an horizontal area of 45½ yards there would be no appreciable curvature from such a source. If the faults had all been vertical, or inclined in parallel directions, I should have been inclined to adopt Sir C. Lyell's theory of cavities, but on a smaller scale, such, for instance, as might be caused by the carrying away, by percolating water, of salt, gypsum or other mineral in chemical solution, or, under certain circumstances, in mechanical suspension. The sinking of a stratum into a cavity could produce such faulting as shown in Fig. 1. For the present case I would suggest the following explanation in want of a better :—

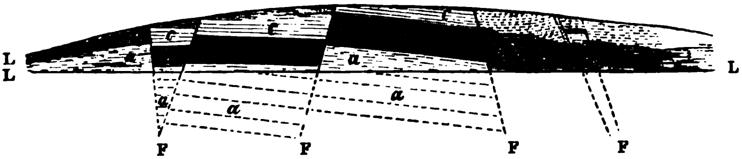
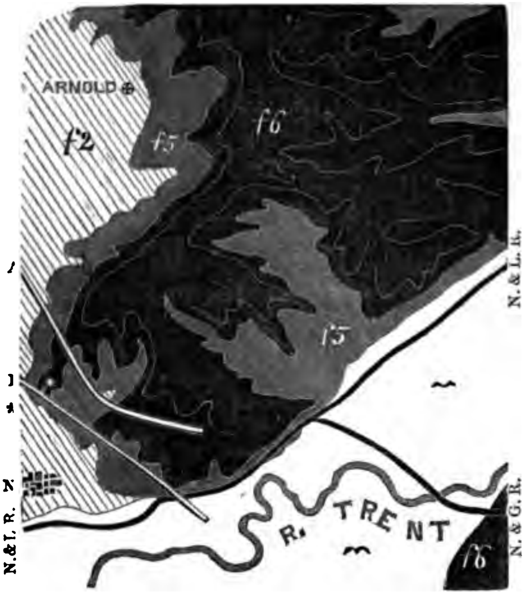


Fig. 1. Section of New Red Marls, Mapperley Road, Nottingham. Average height of section, 5 feet 4 inches. Total length, 136 feet 6 inches. Greatest amount of faulting ascertainable, 2 feet 6 inches. L. L., Level of the Road. The strata on the right of section are obscured by distortion and exposure to the atmosphere. F F F lines of faulting. The letters *a a*, *b b*, *c c*, indicate the portions of the dislocated beds which were once continuous.

I mentioned that the section as shown in Fig. 1 lies at the top of a hill between two faults, as shown in plan (See Fig. 2). Not that the district between the two faults is a continuous ridge; there are other ridges with dry, irregular valleys between. I think there can be no doubt that the space between the two faults has been raised higher than the outlying district so short a time ago (geologically), that the country within the faults has since that time preserved a relative, if not an absolute similarity of contour, with that outside the faults.



vv Alluvium.

New Red Sandstone. Keuper. **f6.** Red Marl with beds of White Sandstone.

f5. Soft Sandstone and Marl (Waterstones).

Bunter. **f2.** Pebble-beds or Conglomerate.

A and B, white lines, Faults.

[Near the letter B, between a white and a black star, is the line of section seen in Fig. 1].

N. = Nottingham.

N. & L. R. = Nottingham and Lincoln Railway.

N. & G. R. = Notts and Grantham Railway.

Scale: ½ inch to 1 mile.

Fig. 2.—Sketch-map of a portion of the District near Nottingham, showing the position of the Faults in the Red Marls of the Keuper and Bunter.

Therefore, upon such elevation, perhaps that last one which gave the country its present contour, subject to subsequent denudation, we should have the data for the elevation of a curved surface (not due to the earth's rotundity) producing the faultings shown in Fig. 1. These minor faultings, as far as a mere section across their direction can show, seem to run parallel to the larger, including faults. I have spoken of valleys between the ridges. Would the elevating force act also on the inverted arches those valleys formed? Clearly so; but the results would differ, for faults would be produced which would hade to the *up*throw. The elevation, then, of a basin-shaped curved area I believe is the cause of the production of this class of faults, on a small if not on a large scale. It is also evident that contortions would be produced by the elevation of an inverted arched area, as they are produced by the depression of an arched area.

I understood from Mr. Wilson's paper that the faults will not take place un'ess the area is depressed beneath the sea, and that marine denudation will obliterate all trace of such faults at the surface. But surely if we are to call in wide areas of upheaval, we cannot limit the effects to a marine area any more than we could to a terrestrial area. No doubt at the present day there would be just so much the greater chance of a marine area being raised, as extensive oceans preponderate over extensive continents. Certain great faults have left their impress on the configuration of the country, and if that impress is modified, it is sometimes as much by subaërial as marine denudation. The Bala fault might be quoted as an example. Ed. Wilson.

Nottingham, *June*, 1868.

ON THE DEVELOPMENT OF THE LOOP IN THE TEREBRATULIDÆ.

Sir,—In your last number, Mr. C. J. A. Meÿer, in a paper on Cretaceous Brachiopoda, offers some observations on the loop of *Waldheimia*, *Terebratula*, *Terebratella*, etc.

I do not wish to enter into a discussion on the desirability of separating the two former generically, the greater or lesser extension of the loop being their only distinction, but simply to say that the correctness of the figures given in my paper on "The Development of the Loop in *Terebratella*," Geologist, vol. iii., pl. xii., figs. 1–4, does not admit of a moment's doubt. They are not, as suggested by Mr. Meÿer, very minute; and as, in the examples figured, the loops are entirely free from the matrix, they can be studied with the greatest advantage. The original sketches of the loops having been carefully drawn by Mr. Davidson will be a sufficient guarantee that they are correct.

However difficult may be the question of a change in the calcified interiors of some of the Brachiopoda, it is quite certain that with the *Terebratella Buckmanii* we have a series of shells, none of which can be separated by their external conditions, but which have notwithstanding different forms of loops; and it will be necessary either to accept the suggestion that they are different stages of growth, or else to create separate *generic* designations for shells that cannot by their outer forms even be distinguished specifically. There is little doubt that had they been obtained singly from different formations the former would most probably have happened.

It may interest some of your readers to know that I have just found the genus *Thecidium* in one of the lead veins of the Carboniferous Limestone of Yorkshire, it not having been met with hitherto in England below the Lias, or on the continent below the St. Cassian Beds. The precise age of the vein yielding it will yet have to be determined. Charles Moore.

Bath, *June* 18, 1868.

DENUDATION NOW IN PROGRESS.

Sir,—In the very interesting and able article in your last number, "On Denudation now in Progress," by Mr. Geikie, he has omitted to take into consideration some circumstances of a restorative character which tend to neutralize the waste of land now going on from subaërial causes.

1st, The formation of vegetable soil, often difficult to account for, the depth in some cases being much greater than in others, and apparently without an assignable cause.[1]

I have often observed on the grass table-land of the Cotswold range, where valleys intervene so as to prevent soil being washed from a higher elevation, that there is a tendency to an increased depth of soil rather than to a diminution, and I think the same is the case with all pasture-land. I have lately seen an instance of how quickly grass will spring up and form turf in an occupation road, which was made about six years since, on a common in the Inferior Oolite, left perfectly bare, and covered with broken stone, which is now grassed over. Of course there is no carriage traffic upon it.

In woods there is often a considerable thickness of soil, arising from the decomposition of leaves; and, I believe, the decay of grass-roots, the manure from the cattle which graze upon the grass, fully if not more than neutralizes the soil which is carried away on permanent pasture ground, by rain. We know also that the surface of the soil is increased by the enormous deposits of coprolites and guano.

2nd. The quantity of different matter returned to the soil mainly in the form of manure is very considerable. In 1867 there were in the United Kingdom 11,431,940 acres of land planted with grain, and I estimate the produce to have been 10,087,931 tons, and in addition 14,217,941 tons of straw. There were also 1,493,762 acres under potatoes, 2,805,775 under turnips, mangolds, carrots, beet, etc., and 630,878 rape and colza. Of clover and other grasses the acreage was 5,648,425 acres, and permanent pasture 22,128,391 acres. At present I have not sufficient information to allow of my calculating the produce of the green crops. From the Government returns I find that there were imported in 1867, not including linseed oil-cake, and cotton seed, which are not given, of wheat, flour, barley, oats, maize, rye, buckwheat, peas, and beans, 3,117,140 tons.

I am fully aware that these figures do not accurately represent the addition to the soil, that the imports of 3,117,140 tons are taken away from other countries, and it is necessary to consider what amount the grain, grass, roots, etc., would produce in feeding the upwards of 46,770,000 cattle, sheep, and pigs in the United Kingdom, and which again must be converted to form part of the food of our people before it is returned to the land. Some allowance would have to be made for the amount subtracted from the soil in growing the grain, grass, and roots.

These figures may, however, enable an approximate estimate to be formed, and my object in writing has been to supply information of rather a special nature, which those who have studied denudation more attentively than I have, can appropriate for the benefit of all.

Claremont House, Gloucester. W. C. Lucy.

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[1] Mr. Jukes, in his Manual, remarks that vegetable soil has not received the attention it merits.

THE

GEOLOGICAL MAGAZINE.

No. L.—AUGUST, 1868.

ORIGINAL ARTICLES.

I.—The Chalk of Antrim.

By J. Beete Jukes, M.A., F.R.S., &c. &c.

Most geologists are aware that the Chalk of Antrim, although full of flints and fossils like those in the English Chalk, is a hard splintery limestone, known here as the "White Limestone." Its induration is often attributed to the action of the basaltic covering which spreads over it, and the coincidence of the two things is certainly remarkable; but I think I can now show that they are not connected in the way of cause and effect.

The upper surface of the Antrim Chalk is frequently, perhaps always, covered with a layer of flint gravel, from one or two to six feet in thickness, often filling up small hollows in the surface of the Chalk. Over this comes the basaltic mass, commonly composed of thick ranges of columnar basalt, each range resting on, and covered by, amygdaloidal beds, which often exhibit a rude lamination or stratification that may perhaps indicate the lines of flow. Thin beds of clay with lignite and iron-ore occur occasionally between the basaltic seams.

It is remarkable that the flints in the flint-gravel which lies between the Basalt and the top of the Chalk, are often, when broken open, found to exhibit concentric bands of various tints of red surrounding a grey interior, and coated by an external white coat; the latter appearing to be due to weathering after the red tints were acquired.

I had been inclined on previous visits to Antrim to attribute this reddening of the interior of the flints, in the gravel between the Basalt and the Chalk, to the igneous action of the former upon them. A recent observation, however, made while inspecting the work of Mr. Du Noyer, and our two new assistants, Messrs. Warren and W. B. Leonard, has led me to doubt even this.

At a quarry (known as McGarry's quarry), about three or four miles W.N.W. of Lisburn, we observed the facts indicated in diagram below :—

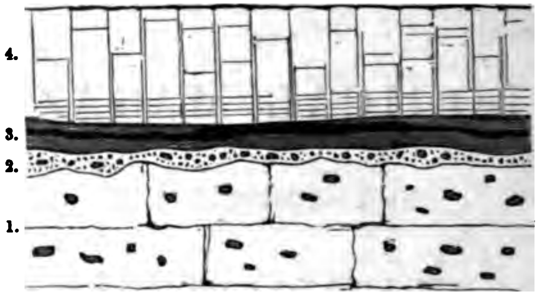


Diagram-section, McGarry's Quarry, W.N.W. of Lisburn, Co. Antrim.

4. Columnar Basalt getting platy below. 3. Clay and Lignite, or Culm.
2. Flint gravel, the flints generally reddened internally. 1. Chalk with grey flints.

The Chalk showed a total thickness of about forty feet, and dipped westerly at about 10°, the green "Mulatto stone" appearing from underneath it at the eastern corner of the quarry. The Chalk has the usual covering of flint gravel, which in some places attains a thickness of three or four feet. Over this was a layer of dark clay, like a coarse under-clay of the Coal-measures, showing a platy lamination in the part exposed to the air, but being quite soft and unctuous when dug into for a few inches. In the upper part of this was a band, three or four inches thick, of a kind of lignite, sometimes more like culm in some parts, splitting into cubical pieces with a bright face like some coals. Over this came coarsely columnar basalt, of which a thickness of thirty feet was shown in one part of the quarry. The lower foot or two of this basalt showed a tendency to split into rough flaggy slabs, but the rest was rudely columnar with a few irregular cross-joints.

The lignite often showed a distinct woody fibre, in the pieces of two or three inches in length, which we procured ; but the workmen told us they often got flattened stems of trees, two or three feet long.

In the lower part of the soft clay I got a flint, the size of the fist, which, on being broken, showed the usual concentric red-tinted coats in its interior.

The only legitimate deduction from these facts seems to me to be, that if the superincumbent basalt did not by its transmitted heat indurate the clay and alter the lignite immediately below it, it could not affect the flints in the flint-gravel under that clay, still less the mass of the Chalk under the gravel.

The effects of the numerous dykes and veins of igneous rock in this country, on the rocks they pass through, are often very obvious, but rarely extend for more than a few feet from the walls of the intrusive masses.

I may add that on another day during a visit to the hills on the north of the town of Antrim, I was struck with the resemblance tween some of the rocks in the porphyritic Trachyte there, and ose which make the Pic de Sancy in the Mont Dor country. he county Antrim is like a ruined Auvergne, from which all aces of the old cones and craters have been removed, and only the heets of Trachytic and Doleritic lavas left, including here and ere the remains of the mud of the old lakes, and of the vegetation which grew upon their shores.

As it will be some little time before the maps, sections, and explanations of this district can be issued from the press, I send you, with the sanction of the Director-General, this little notice as a pre-announcement of their interest when they do appear.

Dublin, *July 14th.*

P.S.—I forgot to mention that on our second visit to McGarry's quarry we were accompanied by Dr. Andrews, Vice-President of the Queen's College, Belfast. I have this morning received from him a note in which he informs me that "the carbonaceous lignite," of which he took specimens to examine, "when heated in air, burns without flame like some varieties of charcoal. A specimen exhibiting distinctly the fibrous structure of wood was allowed to dry in thin splinters in a dry atmosphere, and was afterwards calcined at a red heat, in a platinum capsule. Of this 1·387 grammes lost 1·052 grm. by this treatment. The specimen under examination contains therefore 75·8 per cent. of volatile and combustible matter."—J. B. J.

II.—On the Collocation of the Strata at Roswell Hole, near Ely.

By Harry G. Seeley, F.G.S., Assistant to Professor Sedgwick in the Woodwardian Museum of the University of Cambridge.

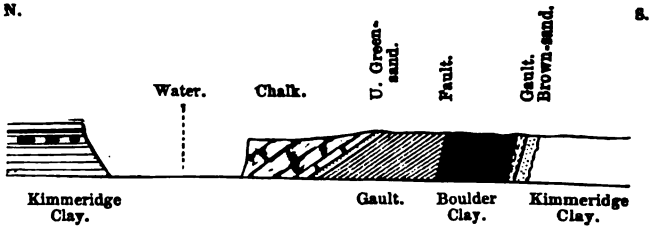
In the Geological Magazine, 1864, Vol. I. p. 150, and 1865, Vol. II. p. 529, two papers of mine appeared upon the strata at Ely. In them, as briefly as might be, are given the sequence of the beds from the Chalk to the Kimmeridge-clay, and the relations of these beds to the Boulder-clay and Kimmeridge-clay on the other side of the pit, where, on all hands, it is allowed to be *in situ.*

All my statements, however, about the sequence and determination of the strata, and of their being faulted, have been called in question in a paper lately read by the Rev. O. Fisher, before the Cambridge Philosophical Society (when I was absent from Cambridge), and which has since been printed in the Proceedings of that Society. In place of the view of the case given in my paper, Mr. Fisher would have us believe that the Cretaceous beds at Ely once formed a boulder, which went careering about the Glacial sea on an iceberg till the iceberg toppled it off into a chink at Ely, which had been made for it by Glacial erosion. If there were no evidence on the other side of the question, no doubt the idea of an intelligent iceberg would be an addition to the poetry of science; but having written facts and drawn facts about the faults in Roswell Hole, seen with my own eyes and those of a hundred other men, and proved with my own hammer and the hammers of many friends, I cannot but ask whether the Boulder hypothesis, coolly resting on its icebergs, is one of those things so beautiful that it must be true, and that the faults urged against it may be ignored?

The facts appeared, and still appear, to me to prove (1) that there is a sequence from Chalk to Kimmeridge-clay; (2) that the sands under the Gault may be connected with the adjacent sands in the fields above the pit; (3) that indubitable slickenside was seen in the vertical junction, forty-five feet high, between the Boulder-clay and the Cretaceous beds figured in Geol. Mag. Vol. II. p. 532.

Since my paper was written the pit has been very much altered, for, by cutting away the Chalk, I saw exposed behind it the Upper Greensand, and behind the Upper Greensand was the Gault, and behind the Gault the brown sands, badly seen, and usually cut through by a fault filled with Boulder-clay; and behind all, the Kimmeridge-clay. So that compared with the section given in Geol. Mag. Vol. I. p. 151, the section now is—

Fig. 1. Section at Roswell Hole, near Ely, as seen May 28, 1868.

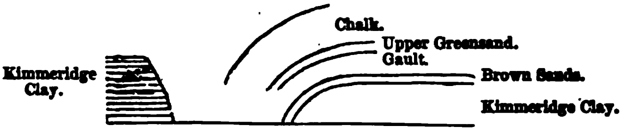


This is parallel with the section in Geol. Mag. Vol. II. p. 532, and at right angles with that at p. 530. There are several minor slips; one last year was exposed, and showed a smooth surface along its visible face of 100 yards. It is apparently on the above or some similar section that Mr. Fisher would ground his case. He also, in the text, throws doubt on my identification of the clay under the Upper Greensand as "Gault," but, in a note, says he has seen "the Lower Greensand in sequence to this clay, which would make it true Gault." If so why print the doubt? Any one who pleases may go and collect from the clay twenty or more of the most characteristic Gault species. I did so in 1862 and again last year, and anyone who pleases may see the clay resting on the brown sands, as I figured it in 1865, and as Mr. Fisher saw it in 1867. I think, then, we are agreed that there is a sequence through the Chalk, Upper Greensand, Gault, and Brown Sands under the Gault. But further on in the text, p. 55, referring to the cottage on the bank, Mr. Fisher says, "I believe the Lower Greensand blocks which occur on the north (? south) side hereabouts to be no more *in situ* than the Chalk." Very likely. They are strewn all down the bank. Now in 1861 and in the spring of 1862, by removing the superimposed Gault a large floor of sand-rock called Lower

Greensand was exposed, it sloped down almost to the water's edge, and was quarried for months. I myself saw it then, in company with Mr. John Ruthven and Mr. Robert Farren. And this sand-rock and conglomerate I ascertained in August, 1862, when the quarrying was done, to rest on the Kimmeridge clay with *Lingula ovalis*, apparently conformably, and like all the superimposed strata dipping to the north. This is stated in my original paper. And now having made the statement fully, I leave it to geologists to judge whether hardness of belief can invalidate the fact.

If any one will notice how the brown sands rise to the surface to the south, and have been quarried in the fields to the south, I think there will be little doubt that the strata, approximately horizontal, dip rapidly over into the pit, thus—

Fig. 2. Diagram to explain the approximate dip of Strata at Roswell Hole, near Ely.



and the upper beds cut level and fractured in the downward dip have left the section as figured above. And against these Cretaceous strata the Boulder-clay abuts; it formerly hid everything but the Chalk, and still extends in front of the Gault and brown sands as shown in Geol. Mag., Vol. II. p. 532. There, in 1862, I saw in the clean section, 45 feet high, the most indubitable slickenside. I have seen it often since, and I have no doubt that anyone who took the trouble to look would find that it still showed him its glistening smooth face.

Any one who will place himself at the point represented in Fig. 2, p. 532, Vol. II. Geol. Mag., will see that the Boulder-clay figured in Section 1 of this paper is a film of Boulder-clay behind the Boulder-clay in the former figure. The fact of Mr. Fisher not having seen slickenside cannot be taken as evidence that it does not exist, unless it is certain that that gentleman has seen everything, of which hitherto we have had no proof.

I therefore reiterate the statements made in my former papers, believing that Mr. Fisher has, not only, not added any new fact by his paper, but has failed in his attempt to cast a doubt on mine.

III.—The Drift-Beds of Llandrillo Bay, Denbighshire.

By Miss Eyton.

In a former number of the Geological Magazine[1] I attempted to describe the old sea-beach which extends along the coast of Llandrillo Bay, and continues round the Great Orme's Head mountain. It is my purpose now to draw attention to the series of Drift-beds, belonging to both the Post Pliocene and recent periods, which are

[1] Vol. III., July, 1866.

here so well defined within a short space, and it is the more desirable to do so, because the encroachments of the sea are annually producing great changes in this district.

1. *The Boulder-clay.*—This deposit attains its greatest thickness on the east of Penmaen Rhos, in the little vale of Llandulas, where its height cannot be much less in some places than 200 feet above the sea level. It forms a fine cliff, where it reposes against the mountain, rising sheer up from the beach nearly to the limestone summit. From thence it slopes gradually downwards to the centre of the valley, forming a terrace of from twenty to fifty feet above the beach. Very curious are the figures into which the recent wave-action has moulded the plastic clay along this terrace. Turrets, caves, and buttresses rise in miniature imitation of the bolder scenery of a more rocky sea-board.

The littoral zone is strewn with huge boulders and sub-angular fragments, which have been left by the denuding action of the waves, the clay and lighter material being borne away, while the heavier portions remained in, or near their original site. Many of these are derived from the subjacent Carboniferous Limestone, others from the dark grey Cambrian rocks of the Snowdon district. I have found among them beautiful specimens of corals, smooth and polished, as though fresh from the hand of the lapidary, while the scratches and striæ on the blocks in this gigantic stoneyard might have been left but yesterday by the workman's chisel.

Crossing the littoral zone, we find the Boulder-clay again reappearing just above low-water-mark. It is, indeed, merely concealed by the sand and shingle of the beach, showing that a continuous slope once extended into what is now the bed of the sea. The whole belt of Carboniferous Limestone, underlying the clay, is rent by huge fissures, commencing near the summits of the hills, and increasing in width and length as they proceed downwards. They are frequently exposed in the course of the quarrying operations, which are extensively carried on in this locality, and are generally found to be filled with Boulder-clay and its included debris, the sides being coated with stalagmitic concretions of a dark red colour, derived from the oxide of iron,[1] contained in the clay. From this and from a similar tint imparted to the limestone, where the clay has rested against it, the name Penmaen Rhos (red-head-land) is derived. The quarrymen informed us that they sometimes found deer's horns in these fissures, but we were unable to procure any. The rents appear to have been formed by frosts; a little water being lodged in a crevice in the rock froze, thus enlarging the crack; next winter the process was repeated on a larger scale, and so on, until the mild Pliocene climate had changed into the cold of the Glacial epoch, and the great rivers of ice came crashing and grinding over the land, involving all in one common ruin, —ruin from which, however, phœnix-like, new life was to arise.

It will be seen from the foregoing observations that the Boulder-clay in this locality once occupied a very much larger space than at

[1] Anhydrated peroxide according to Mr. George Maw.

present, both as to depth and area;—covering the summits of hills some 400 or 500 feet in height, and extending, probably, far out into what is now the Irish Channel. Then came the period of denudation, when the land sunk beneath the waters of the Glacial ocean, which, rising over these summits, and others much higher,[1] washed away the lighter material, leaving the heavy boulders standing—as they are so often found—in their original position.

It is by considering the miniature operations of the present sea, that the conclusion is arrived at, that the denudation of the Boulder-clay was mainly effected by an advancing, not a retiring, ocean. The latter, having expended most of its force, appears to have little influence in altering the surface of the land, though it leaves behind it much of the material which it had previously accumulated and held in suspension, but which it is unable to carry away. Its tendency is rather to produce smooth slopes and rounded outlines, than sharply defined cliffs, or any of the forms which are the result of undermining action. Therefore, while extensive denuding operations, including the formation of caves and terraces, are marks of the sinking of the land, I conceive that the deposition of marine drift may be considered a token of its rising, and of the consequent subsidence of the water.

2nd. *Glacio-marine Drift.* On the western side of Penmaen Rhos the Boulder-clay thins out, and we find reposing upon it, against the hill side, a differently constituted Drift; while in the lower part of the glen, near the village of Colwyn, the Boulder-formation has been almost entirely removed and the same Drift substituted. Whether this removal was effected entirely by marine agency; or whether, the land having risen, its surface was again ploughed by glaciers and again submerged before the deposition of this second drift, there is here no evidence to point out. The Drift is composed of small pebbles, about the size of a pea, rounded and flattened, and closely packed, mixed with sand, the whole being cemented together by clay. It attains the greatest thickness towards the centre of the glen, where it is cut into by a small brook, on the banks of which many good sections may be found. In some places it is slightly bedded. I never succeeded in finding any perfect organic remains in this bed, but have frequently detected minute fragments of shells among the sand. This is accounted for, if we suppose it to have been subjected to Glacial as well as marine action. I found the same Drift near the caves at Tanr'ogo. Further observation convinces me that the interior of these caves, as well as of those of Cefn Ogo, near St. Asaph, and the smaller ones on the beach at the foot of Penmaen Rhos, are of far older date than the associated Drift, being simply openings in the Glacial fissures into which the rising sea has obtained an entrance, and has hollowed them into caverns with arched entrances.[2] Could the necessary means and permission be obtained, I feel convinced that the Tanr'ogo caves would well repay the task of excavation.

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[1] Sir Charles Lyell speaks of drift-beds containing marine shells on Moel Tryfaen, 1360 feet above the sea level (Elements of Geology, p. 158).

[2] Query. May not some of the bones found in these and similar caves have been washed in through the fissures with the Boulder-clay, although the caves themselves

3rd. *Recent Marine Drift.*—Proceeding onwards round Llandrillo Bay to the west, we arrive at the headland of Rhos-yn-Llandrillo, a low point of land projecting out into the sea. A low terrace rises directly from the beach just above high-water-mark, veiled for the most part by surface soil, with its growth of scanty herbage. This covering has apparently been washed away by the sea in one spot, immediately beyond the residence of Mr. Parry Evans, and the true face of the cliff exposed, exhibiting the following section:—

	Feet.	Inches.
a. Surface soil, about	0	2
b. Pebble band without shells	0	5
c. Hard sand and clay conglomerate ...	2	10
d. Do. containing shells and pebbles ...	1	6

The latter bed is an entire mass of shelly conglomerate, the sand being largely made up of comminuted fragments. The following is a list of species:—*Ostrea edulis; Buccinum undatum; Purpura lapillus; Patella vulgata; Litorina litorea.*

The shells were much rolled and comminuted—the specimens of *Purpura lapillus* often nearly resembling round pebbles. I was struck by the total absence of *Mytilus edulis*, now so common on this coast, and which is found so abundantly in the surface mould of the Great Orme's Head. Mr. Parry Evans informed me that in digging the foundations of a sea-wall opposite his house, many similar shells had been found.

I have not overlooked the possibility that this bed might be a shell-mound of human origin, but the rolled appearance of the shells, as well as the absence, as far as I could discover, of bones or works of art, seem to dispose of this hypothesis.

I have to thank Mr Parry Evans for his courtesy in allowing me to undermine the bank beneath his cornfield in the search.

4th. *Submarine Forest Bed.*—Between the high and low tide marks on the same peninsula, there occurs a bed of stiff blue clay, full of the remains of trees, chiefly oak and hazel. One large root of the former was still in its original position, a pool of sea-water occupying the hollow stump. It measured 9 feet 6 inches in girth. A trunk 15 feet long lay extended upon the beach. The hazel was in a soft and pulpy condition, the oak harder. Now this forest, although probably of historical date, must have existed in very early times, since the weir which now stands here, is the same that was granted to the Cistercian monks of Conway,[1] and consequently the sea then stood at the same level as it does now. Between the formation of these two beds, there must have elapsed a period long enough to allow the retreating waters (after having contributed their appointed

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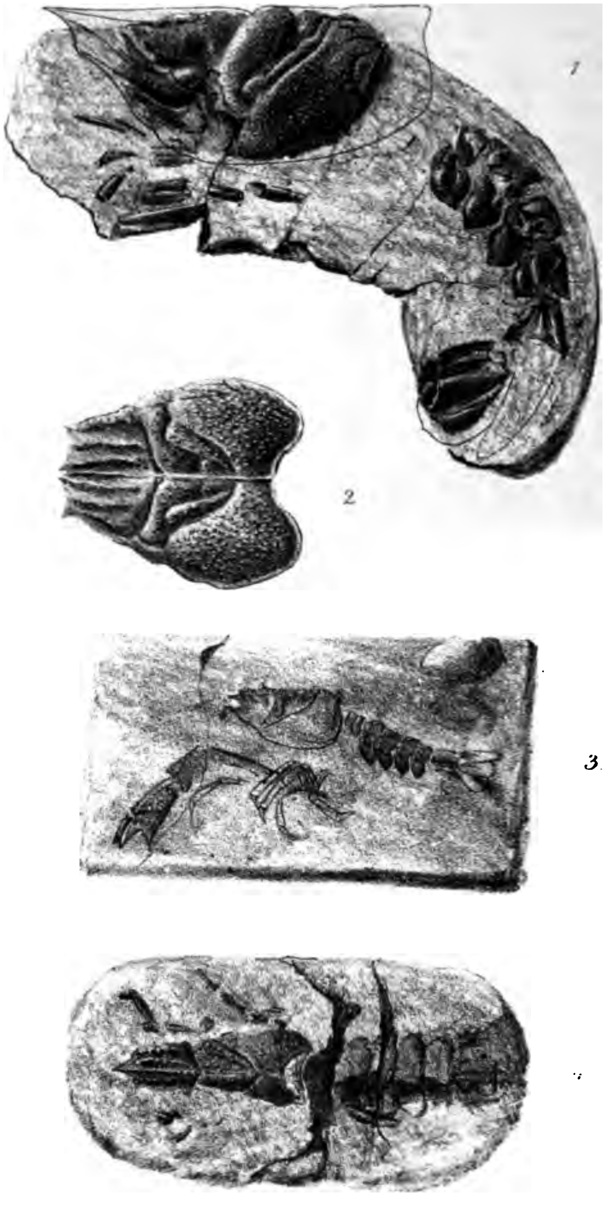
may have been occupied as dens, or human habitations at a later date; and would not this account for the strange mixture of remains of animals belonging to different climates so often found in them?

[1] "The Abbey was founded by Llewellyn ap Jorwerth, Prince of North Wales, in 1185, in honour of the Blessed Virgin and all saints." (See Pennant's Tours in Wales, vol. iii., p. 127.)



W. West imp.

Lower Lias Crustacea

portion to the writing of the world's history) to subside, we know not how far; while trees, not scanty seaside-herbage, flourished upon the land lately washed by the waves, until a fresh oscillation took place, and the sea resumed its sway; fish swam among the forest boughs and the mollusc tribe dwelt among the roots, and thus the sea continues, eating into the land, winter by winter, until the traces of its former presence will soon be obliterated or overwhelmed.

I conceive this forest to have been contemporary with many of those whose remnants occur in the interior in peat-mosses, and which must have flourished at a period subsequent to that of the low-level drifts, when the land stood at a higher level than now; the marine bed may probably be correlated with those drifts, and thus both might be included in the recent, or human period.

IV.—CONTRIBUTIONS TO BRITISH FOSSIL CRUSTACEA.

BY HENRY WOODWARD, F.G.S., F.Z.S.

(*Continued from Page* 261.)

[PLATE XVII.]

IV. THE genus *Pseudoglyphea* was established in 1860[1] by the late Dr. Albert Oppel, of Munich, for certain remains of Crustacea occurring in the Oolite and Lias formations of Bavaria, &c., previously referred to the genus *Glyphea*, from which, however, he has separated them on account of the difference in the direction of the furrows which mark the regions of the cephalothorax. Whether these characters will be found to be supported by others, or, to be in themselves of sufficient importance to justify the retention of the genus, must be determined by more ample materials and a better acquaintance with the entire animals belonging to both genera than we are at present able to command.

After a careful examination of the large series of Oolitic specimens from the collection of the late Mr. William Bean, of Scarborough, preserved in the British Museum, I think it can be shown, that, in addition to the distinctive characters of the carapace, *Pseudoglyphea* had well-developed claws (chelæ) to the first pair of legs:[2] whereas in *Glyphea* the penultimate joint (from which the opposing fixed ramus of the chela is developed), only bears a small spine; so that the fore-legs in *Glyphea* may be said to be monodactylous. The specimen Fig. 1 in Plate XVII., is from the rich collection of Charles Moore, Esq., F.G.S., of Bath, and was obtained from the Lower Lias of Weston, near Bath. The nodule containing the fossil has been adroitly split open in a line with the body of the animal, and exhibits the left side of the cephalothorax, and five of the abdominal rings, and two of the side-swimming-plates of the telson, but the median plate is wanting, as is also the first abdominal segment.

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[1] Palaeontologische Mittheilungen aus dem Museum des Koenigl. Bayer. Staates, von Dr. Albert Oppel, Stuttgart, 1862, p. 51.

[2] Xth. pair of appendages: see table of appendages of Crustacea, in Pal. Soc. Vol. xix., 1865, Monograph on the Merostomata, pp. 4 and 5.

I have little doubt in referring this to Hermann von Meyer's *Glyphea grandis*,[1] (since placed by Oppel in his genus of *Pseudoglyphea*,)[2] from the Lias of Tübingen. The carapace, which is finely granulated, measures two inches in extreme length, and nine lines in greatest breadth of side. Two nearly parallel furrows pass from the dorsal line obliquely across the side of the carapace, separating the branchial from the cardiac region, and terminating in a smooth rounded prominence on the hepatic region. The nuchal furrow, between the cardiac and gastric regions, is short and deeply indented; the frontal portion of the carapace is marked by two lines of small tubercles, converging towards the rostrum, which is short, but pointed (as in *Astacus*); the orbits are shallow. The abdomen is 1½ inch in length, the segments are granulated like the cephalothorax, the epimera are falcate and finely serrated upon their posterior borders. The plates of the telson are 7 lines in length and 4 lines in breadth; the exterior plate is divided near the lower margin by an oblique suture as in *Astacus* and *Homarus*. The long and slender walking legs can be seen imperfectly preserved, but their terminations are not visible. The anterior pair of legs were chelate but the evidence of this is derived from other examples.

I have already alluded to this example[3] as the *Pseudoglyphea Winwoodi*, sp. nov., but, after a further examination, I am obliged to refer it to H. von Meyer's species, *P. grandis*, which, although founded upon a less perfect example than that figured in our plate, appears nevertheless to be identical.

The following species of *Pseudoglyphea* have been enumerated by Dr. Oppel:—

Pseudoglyphea grandis, Meyer, sp. Lr. Lias, Tübingen; Weston.
„ *Ettaloni*, Oppel, M. Lias, Pegney and Chalindrey.
„ *amalthea*, Oppel, M. Lias, Boll, Wurtemberg.
„ *stricta*, Etallon, U. Lias, Corlée, Normandy.
„ *eximia*, Oppel, Oxfordian, Dept. Meurthe.
„ *Terquemi*, Oppel, Oxfordian, Dept. Meurthe.

To this genus must also be referred the *Astacus Birdii*, of Bean, MS. from the Inferior Oolite, Peak, Yorkshire, and four other carapaces (to be hereafter figured), 1. from the Oolite beds, railway cutting, near Stamford, collected by Prof. Morris, (Mus. Brit.); 2. from the Lower Lias, Northampton, collection of Samuel Sharp, Esq., F.S.A., F.G.S.; 3. from the Oolite of Shotover, collected by W. Cunnington, Esq., F.G.S., (Mus. Brit.); 4. Middle Lias, Dundas, near Bath, collection of C. Moore, Esq., F.G.S. Two chelae, from the Cornbrash of Chippenham, probably also belong to this genus, but more evidence is needed before the species can be safely determined.

V. The detached cephalothorax (Plate XVII. Fig. 2) is referable to the genus *Glyphea*, as restricted by Dr. Oppel.[4] It was obtained by the Rev. H. H. Winwood, M.A., F.G.S., from the Lower Lias of Weston, near Bath, who kindly obliged me with a cast of it for examination.

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[1] Neue Gattungen Fossiler Krebse aus gebilden vom Bunten sandstein bis in die Kreide, von Hermann von Meyer, Stuttgart, 1840, Taf. iv., Fig. 27.

[2] Palaeontologische Mittheilungen, p. 52.

[3] British Association Reports, Dundee, 1867, p. 46.

[4] Palaeontologische Mittheilungen, p. 56.

The carapace, which measures 13 lines in length along the mesial line, and 13 lines in breadth across the branchial region, is so disposed upon the matrix as to exhibit both sides in nearly the same plane: I have observed several specimens in this condition from the Oolite of Malton, Yorkshire. The surface is finely granulated, the regions of the carapace are tumid, the nuchal furrow is deep and nearly transverse, the part anterior to it is marked by three ridges, disposed nearly parallel to each other, on either side of the median ridge; the cardiac region is separated from the branchial by two furrows, which commencing on the dorsal line 2¼ lines from the posterior border of the carapace, extend forward in two diverging V-shaped lines down either side until they nearly touch the nuchal furrow, when the inner furrow is curved back, uniting with the outer, and encircling the hepatic region, it joins the nuchal furrow near the lateral margin.

I have carefully compared Fig. 2 with a large series of specimens from the Oolite of Yorkshire, Normandy, and Germany, and I find—although at first disposed to consider it specifically distinct—that I must refer it to the *Glyphea* (*Astacus*) *rostrata* of Phillips,[1] which, although usually larger in proportion, has precisely the same disposition of the regions and furrows of the carapace. The species occurs at Malton and Scarboro', in Yorkshire; at Besancon and Ru, near Vesoul, and some localities in Normandy; and Weston, near Bath. (Collns.: British Museum, and Rev. H. H. Winwood, F.G.S., Bath.)

VI. Another species of *Glyphea* (Plate XVII., Fig. 3) is from the Lower Lias of Lyme Regis, Dorset, and was collected by E. C. H. Day, Esq., F.G.S., formerly of Charmouth.

It measures 17 lines in extreme lengh, of which the carapace is 7 and the abdomen 10 lines. All the legs are monodactylous; the penultimate joint of the fore-leg is broad and flattened, the surface rugose; the rostrum is armed with several short, erect spines; the surface of the carapace on the branchial regions is scabrous; the body-segments are smooth, save near the epimera, when they become slightly rugose; the borders are falcate, and armed with minute spines. The antennæ are not preserved.

Although our specimen differs slightly from Dr. Oppel's figure of *Glyphea Heeri* [Palæontologische Mittheilungen, etc., Tab. 15, Fig. 1, from the Lower Lias, Schambelen by Mülligen, Baden, Canton Aargau], in the form of the distal end of the penultimate joint of the fore-leg, and in the more pointed form of the epimera of the abdominal segments, yet in other respects they appear to agree so closely, that I think it better to await more perfect materials before venturing to separate them. (The original is preserved in the British Museum.)

VII. The fourth crustacean figured on Plate XVII., Fig. 4, also belong to the genus *Glyphea*, and is from the collection of R. F. Tomes, Esq., who obtained it from the Lower Lias (zone of *Ammonites semicostatus*). Welford Hill, Stratford-on-Avon, Warwickshire.

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[1] Geol. Yorkshire, Part 1, Pl. IV., Fig. 20, from the Coralline Oolite.

The specimen exhibits the dorsal aspect in almost a perfect state; and is 2 inches in extreme length, of which the carapace measures 11 lines, the abdominal segments 9 lines, and the telson 4 lines.

The rostrum is 1 line in length; the carapace is strongly indented by the nuchal furrow 5 lines from its frontal border, the part anterior to the nuchal furrow being ornamented by two parallel lines of small tubercles on each side of the rostrum, the interspaces being smooth.

Two furrows, not differing greatly in position from those on the carapace of *Glyphea rostrata*, divide the cardiac and branchial regions, the surface of which is thickly studded with minute tubercles. The legs are slender and appear to be monodactylous. The epimera of the abdominal segments are obtuse and have a raised border; the surface of the segments was smooth and destitute of punctae or tubercles. The lamina of the tail are broad, and the exterior plate is divided transversely near its extremity by a line of suture, as already described in the genus *Pseudoglyphea*.

This elegant little crustacean cannot be referred to any published species with which I am acquainted; it nearly approaches the *Glyphea Münsteri*, of Voltz, from the Oxfordian of St. Scolasse, but they do not agree together in the divisions of the carapace; nor can it be referred to the *G. rostrata*, of Phillips. I have, therefore, fore, much pleasure in naming it *Glyphea Tomesii*, after the discoverer, R. F. Tomes, Esq.

EXPLANATION OF PLATE XVII.

FIG. 1. *Pseudoglyphea grandis*, Meyer, sp. Lower Lias, Weston, near Bath, from the collection of Charles Moore, Esq., F.G.S., Bath.

FIG. 2. *Glyphea rostrata*, Phillips, sp. Lower Lias, Weston, near Bath, from the collection of Rev. H. H. Winwood, M.A., F.G.S., Bath.

FIG. 3. *Glyphea Heeri*, Oppel, Lower Lias, Lyme Regis. Original in the British Museum.

FIG. 4. *Glyphea Tomesii*, H. Woodward, Lower Lias, Welford Hill, Stratford-on-Avon, from the collection of R. F. Tomes, Esq., Corr. Memb. Zool. Soc.

[All the figures are drawn of the natural size.]

V.—NOTE BY PROFESSOR MORRIS, F.G.S., ON ORGANIC REMAINS IN THE SOMERSETSHIRE COAL-FIELD.

THE occurrence of invertebrate animal-remains in the Somersetshire Coal-field has not, I believe, been very frequently noticed. With the view of drawing attention to the subject, I send a brief notice of a few remains which I had the pleasure of collecting during a visit with Mr. J. Prestwich to this district, hoping that the local geologists, or members of the Natural History Societies, may be induced to record the observations they have made, or further prosecute enquiries into the occurrence of the animal-remains, either vertebrate or invertebrate, which may be associated with the rich and interesting flora of this Coal-field. Casts of bivalve mollusca (*Anthracoptera ?*) were detected in the coal-shale at Twerton, near

Bath, but I was not fortunate in finding any similar shales at the other coal-pits visited. Remains of *Entomostraca* were, however, tolerably abundant at one or two localities, and I have little doubt would yield a rich harvest to any local investigator. Having submitted the few specimens I obtained to Professor Rupert Jones, that gentleman has kindly determined them. From the bituminous shale of Mr. Farrar's pit at Nailsea; *Estheria striata*, var. *Beinertiana* (Mon. Foss. Estheriæ, Pl. I., Fig. 13), with intercostal spaces distinctly wide, but not shewing ornament; also an imperfect cast of *Beyrichia arcuata?* From the roof of the white seam of Youngwood pit, Nailsea, were obtained *Kirkbya costata*, not in good condition, and partly-imbedded well preserved specimens, of a species of *Cythere*, as well as some indeterminable casts. In the shale, about 200 feet above the white seam of the last pit, was observed an *Ostracod* imbedded with its surface downwards, closely resembling *Cythere fabulina*. Numerous seed-vessels (*sporangia*) were likewise observed in the Coal-shales of Bedminster and Yate, referable probably to *Flemingites* or *Lepidodendron* (see Geol. Mag., 1865, Vol. II., p. 433, Plate XII).

In a letter, just received from Mr M'Murtrie, he states that, "at Radstock no animal-remains have been found in the Coal-measures, but that at Camerton several specimens of bivalve shells (*Anthracosia?*) and two specimens of *Limulus* have been found by Mr E. Feare." J. M.

NOTICES OF MEMOIRS.

I.—On the Animals which are most nearly intermediate between Birds and Reptiles.[1]

By Professor Huxley, LL.D., F.R.S.

THOSE who hold the doctrine of Evolution (and I am one of them) conceive that there are grounds for believing that the world, with all that is in it and on it, did not come into existence in the condition in which we now see it, nor in anything approaching that condition.

On the contrary, they hold that the present conformation and composition of the earth's crust, the distribution of land and water, and the infinitely diversified forms of animals and plants which constitute its present population, are merely the final terms in an immense series of changes which have been brought about, in the course of immeasurable time, by the operation of causes more or less similar to those which are at work at the present day.

Perhaps this doctrine of Evolution is not maintained consciously, and in its logical integrity, by a very great number of persons.[2] But many hold particular applications of it without committing themselves to the whole; and many, on the other hand, favour the general doctrine without giving an absolute assent to its particular applications.

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[1] Being a Lecture delivered at the Royal Institution of Great Britain, on Friday, February 7, 1868.

[2] The only complete and systematic statement of the doctrine with which I am acquainted is that contained in Mr. Herbert Spencer's "System of Philosophy," a work which should be carefully studied by all who desire to know whither scientific thought is tending.

Thus, one who adopts the nebular hypothesis in Astronomy, or is a Uniformitarian in Geology, or a Darwinian in Biology, is, so far, an adherent of the doctrine of Evolution.

And, as I can testify from personal experience, it is possible to have a complete faith in the general doctrine of Evolution and yet to hesitate in accepting the Nebular, or the Uniformitarian, or the Darwinian hypotheses in all their integrity and fullness. For many of the objections which are brought against these various hypotheses affect them only, and even if they be valid, leave the general doctrine of Evolution untouched.

On the other hand, it must be admitted that some arguments which are adduced against particular forms of the doctrine of Evolution, would very seriously affect the whole doctrine if they were proof against refutation.

For example, there is an objection which I see constantly and confidently urged against Mr. Darwin's views, but which really strikes at the heart of the whole doctrine of Evolution, so far as it is applied to the organic world.

It is admitted on all sides that existing animals and plants are marked out by natural intervals into sundry very distinct groups:—Insects are widely different from Fish—Fish from Reptiles—Reptiles from Mammals—and so on. And out of this fact arises the very pertinent objection,—How is it, if all animals have proceeded by gradual modification from a common stock, that these great gaps exist?

We, who believe in Evolution, reply, that these gaps were once non-existent; that the connecting forms existed in previous epochs of the world's history, but that they have died out.

Naturally enough, then, we are asked to produce these extinct forms of life. Among the innumerable fossils of all ages which exist, we are asked to point to those which constitute such connecting forms.

Our reply to this request is, in most cases, an admission that such forms are not forthcoming, and we account for this failure of the needful evidence by the known imperfection of the geological record. We say that the series of formations with which we are acquainted is but a small fraction of those which have existed, and that between those which we know there are great breaks and gaps.

I believe that these excuses have very great force; but I cannot smother the uncomfortable feeling that they are excuses.

If a landed proprietor is asked to produce the title-deeds of his estate, and is obliged to reply that some of them were destroyed in a fire a century ago, that some were carried off by a dishonest attorney, and that the rest are in a safe somewhere, but that he really cannot lay his hands upon them; he cannot, I think, feel pleasantly secure, though all his allegations may be correct and his ownership indisputable. But a doctrine is a scientific estate, and the holder must always be able to produce his title-deeds, in the way of direct evidence, or take the penalty of that peculiar discomfort to which I have referred.

You will not be surprised, therefore, if I take this opportunity of pointing out that the objection to the doctrine of Evolution, drawn from the supposed absence of intermediate forms in the fossil state, certainly does not hold good in all cases. In short, if I cannot produce the complete title-deeds of the doctrine of animal Evolution, I am able to show a considerable piece of parchment evidently belonging to them.

To superficial observation no two groups of beings can appear to be more entirely dissimilar than Reptiles and Birds. Placed side by side, a Humming-bird and a Tortoise, an Ostrich and a Crocodile, offer the strongest contrast, and a Stork seems to have little but animality in common with the Snake it swallows.

Careful investigation has shown, indeed, that these obvious differences are of a much more superficial character than might have been suspected, and that Reptiles and Birds do really agree much more closely than Birds with Mammals, or Reptiles with Amphibians. But still, "though not as wide as a church-door or as deep as a well," the gap between the two groups, in the present world, is considerable enough.

Without attempting to plunge you into the depths of anatomy, and confining myself to that osseous system to which those who desire to compare extinct with living animals are almost entirely restricted, I may mention the following as the most important differences between all the Birds and Reptiles which at present exist.

1. The pinion of a Bird, which answers to the hand of a man or to the forepaw of a Reptile, contains neither more nor fewer than three fingers. These answer to the thumb and the two succeeding fingers in man, and have their metacarpals connected together by firm bony union, or anchylosed. Claws are developed upon the ends of at most two of the three fingers (that answering to the thumb and the next), and are sometimes entirely absent.

No Reptile with well-developed forelimbs has so few as three fingers; nor are the metacarpal bones of these ever united together; nor do they present fewer than three claws at their terminations.

2. The breast-bone of a Bird becomes converted into membrane-bone, and ossification commences in it from at least two centres.

The breast-bone of no Reptile becomes converted into membrane-bone, nor does it ever ossify from several distinct centres.

3. A considerable number of caudal and lumbar, or dorsal, vertebræ unite together with the proper sacral vertebræ of a Bird to form its "sacrum." In Reptiles the same region of the spine is constituted by the one or two sacral vertebræ.

4. In Birds the haunch-bone (ilium) extends far in front of, as well as behind, the acetabulum; the ischia and pubes are directed backwards, almost parallel with it and with one another; the ischia do not unite in the ventral middle line of the body. In Reptiles, on the contrary, the haunch-bone is not produced in front of the acetabulum;

and the axes of the ischia and pubes diverge and lie more or less at right angles to that of the ilium. The ischia always unite in the middle ventral line of the body.

5. In all Birds the axis of the thigh-bone lies nearly parallel with the median plane of the body (as in ordinary *Mammalia*) in the natural position of the leg. In Reptiles it stands out at a more or less open angle with the median plane.

6. In Birds one half of the tarsus is inseparably united with the tibia, the other half with the metatarsal bone of the foot. This is not the case in Reptiles.

7. Birds never have more than four toes, the fifth being always absent. The metatarsal of the hallux, or great toe, is always short and incomplete above. The other metatarsals are anchylosed together, and unite with one half of the tarsus, so as to form a single bone, which is called the *tarsometatarsus*. Reptiles with completely developed hind-limbs have at fewest four toes, the metatarsals of which are all complete and distinct from one another.

Although all existing Birds differ thus definitely from existing Reptiles, one comparatively small section comes nearer Reptiles than the others. These are the *Ratitæ*, or struthious birds, comprising the Ostrich, Rhea, Emu, Cassowary, *Apteryx*, and the but recently extinct (if they be really extinct) birds of New Zealand, *Dinornis*, etc., which attained gigantic dimensions. All these birds are remarkable for the small size of their wings, the absence of a crest or keel upon the breastbone, and of a complete furcula; in many cases, for the late union of the bones of the pinion, the foot, and the skull. In this last character in the form of the sternum, of the shoulder-girdle, and in some peculiarities of the skull, these birds are more reptilian than the rest; but the total amount of approximation to the reptilian type is but small, and the gap between Reptiles and Birds is but very slightly narrowed by their existence.

How far can this gap be filled up by a reference to the records of the life of past ages?

This question resolves itself into two:—

1. Are any fossil Birds more reptilian than any of those now living?

2. Are any fossil Reptiles more bird-like than living reptiles? And I shall endeavour to show that both these questions must be answered in the affirmative.

It is very instructive to note by how mere a chance it is we happen to know that a fossil bird, more reptilian in some respects than any now living, once existed.

Bones of birds have been obtained from rocks of very various dates in the Tertiary series without revealing any forms but such as would range themselves among existing families.

A few years ago the great Mesozoic formations had yielded only the few fragmentary ornitholites which have been discovered in the Cambridge Greensand, and which are insufficient for the complete determination of the affinities of the bird to which they belonged.

However, the very fine calcareous mud of the ancient Oolitic sea-bottom which has now hardened into the famous Lithographic slate of Solenhofen, and has preserved innumerable delicate organisms of the existence of which we should otherwise have been, in all probability, totally ignorant, in 1861 revealed the impression of a feather to the famous palæontologist, Herman von Meyer. Von Meyer named the unknown bird to which this feather belonged *Archæopteryx lithographica*, and in the same year, the independent discovery by Dr. Häberlein of the precious skeleton of the *Archæopteryx* itself, which now adorns the British Museum,[1] demonstrated the chief characters of this very early bird. But it must be remembered that this feather and this imperfect skeleton are the sole remains of birds which have yet been obtained in all that great series of formations known as Wealden and Oolite, which partly lie above, partly below, and partly correspond with, the Solenhofen slates.

Though some palæontologists may be forced by a sense of consistency to declare that the class of birds was created in the sole person of *Archæopteryx* during the deposition of the Solenhofen slates, and disappeared during the Wealden, to be re-created in the Greensand, to vanish once more during the Cretaceous epoch and reappear in the Tertiaries, I incline to the hypothesis that many birds besides *Archæopteryx* existed throughout all this period of time, and that we know nothing about them, simply because we do not happen to have hit upon those deposits in which their remains are preserved.

Now, what is this *Archæopteryx* like? Unfortunately, the skull is lost, but the leg and foot, the pelvis, the shoulder-girdle, and the feathers, so far as their structure can be made out, are completely those of existing ordinary birds.

On the other hand, the tail is very long, and more like that of a reptile than that of a bird in this respect. Two digits of the manus have curved claws, much stronger than those of any existing bird; and, to all appearance, the metacarpal bones are quite free and disunited.

Thus it is a matter of fact that, in certain particulars, the oldest known bird does exhibit a closer approximation to reptilian structure than any modern bird.

Are any fossil reptiles more bird-like than those which now exist?

As in the case of birds, the Tertiary formations yield no trace of reptiles which depart from the type of the existing groups. But otherwise than is true of birds, the newest of the Mesozoic formations, the Chalk, makes us acquainted with reptiles which, at first sight, seem to approach birds in a very marked manner. These are those flying reptiles, the Pterodactyles, which resemble the great majority of birds in the presence of air-cavities in their bones, in the wonderfully bird-like aspect of their coracoid and scapula, and in their broad sternum with its median crest. Furthermore, in some of the Pterodactyles, the premaxillæ and the symphysial part of the mandibles were prolonged into beaks, which appear to have been sheathed in horn, while the rest of each jaw was armed with teeth.

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[1] The fossil has been described by Professor Owen in the "Philosophical Transactions" for 1863.

But horn-sheathed beaks are found in reptiles as well as in birds; the structure of the scapulo-coracoid arch and of the sternum, and the pneumaticity of the bones, vary greatly among birds themselves; and these characters of the Pterodactyles may be merely adaptive modifications.

On the other hand, the manus has four free digits, the three inner of which are strongly clawed, while the fourth is enormously prolonged, in total contrast to the abortion of the corresponding digit in birds. The pelvis is as wholly unlike that of birds as is the hind-limb and foot.

Thus it appears that Pterodactyles, among reptiles, approach birds much as Bats, among Mammals, may be said to do so. They are a sort of reptilian Bats[1] rather than links between Reptiles and Birds, and it is precisely in those organs which, in birds, are the most characteristically ornithic, the manus and the pes, that they depart most widely from the ornithic type.

Clearly, then, the passage from Reptiles to Birds is not from the flying Reptile to the flying Bird. Let us try another line. I have already observed that, in the existing world, the nearest approximation to Reptiles is presented by certain land Birds, the Ostriches and their allies, all of which are devoid of the power of flight by reason of the small relative size of their fore-limbs and of the character of their feathers.

Can we find any extinct reptiles which approached these flightless birds, not merely in the weakness of their fore-limbs, but in other and more important characters?

I imagine that we can, if we cast our eyes in what at first sight seems to be a most unlikely direction.

The *Dinosauria*, a group of extinct reptiles, containing the genera *Iguanodon, Hadrosaurus, Megalosaurus, Poikilopleuron, Scelidosaurus, Plateosaurus*, etc., which occur throughout the whole series of the Mesozoic rocks, and are, for the most part, of gigantic size, appear to me to furnish the required conditions.

In none of these animals are the skull, or the cervical region of the vertebral column, completely known, while the sternum and the manus have not yet been obtained in any of the genera. In none has any trace of a clavicle been observed.

With regard to the characters which have been positively determined, it has been ascertained, that:—

1. From four to six vertebræ enter into the composition of the sacrum, and become connected with the ilia in a manner which is partly ornithic, partly reptilian.

2. The ilia are prolonged forwards in front of the acetabulum as well as behind it, and the resemblance to the bird's ilium thus produced is greatly increased by the widely arched form of the acetabular margin of the bone, and the extensive perforation of the floor of the acetabulum.

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[1] It will be understood that I do not suggest any direct affinity between Pterodactyles and Bats.

3. The other two components of the *os innominatum* have not been observed actually in place; indeed, only one of them is known at all, but that one is exceedingly remarkable from its strongly ornithic character. It is the bone which has been called "clavicle" in *Megalosaurus* and *Iguanodon* by Cuvier and his successors, though the sagacious Buckland had hinted its real nature.[1] But these bones are not in the least like the clavicles of any animal which possesses a clavicle, while they are extremely similar to the ischia of such a bird as an ostrich; and in the only instance in which they have been found in tolerably undisturbed relation with other parts of the skeleton, namely, in the Maidstone *Iguanodon*, they lie, one upon each side of the body, close to the ilia. I hold it to be certain that these bones belong to the pelvis, and not to the shoulder-girdle, and I think it probable that they are ischia; but I do not deny that they may be pubes.

4. The head of the femur is set-on at right angles to the shaft of the the bone, so that the axis of the thigh-bone must have been parallel with the middle vertical plane of the body, as in birds.

5. The posterior surface of the external condyle of the femur presents a strong crest, which passes between the head of the fibula and the tibia as in birds. There is only a rudiment of this structure in other reptiles.

6. The tibia has a great anterior or "procnemial" crest, convex on the inner, and concave on the outer, side. Nothing comparable to this exists in other reptiles, but a correspondingly developed crest exists in the great majority of birds, especially such as have great walking or swimming powers.

7. The lower extremity of the fibula is much smaller than the other; it is, proportionally, a more slender bone than in other reptiles. In birds the distal end of the fibula thins away to a point, and it is a still more slender bone.

8. *Scelidosaurus* has four complete toes, but there is a rudiment of a fifth metatarsal. The third or middle toe is the largest, and the metatarsal of the hallux is much smaller at its proximal than at its distal end.

Iguanodon has three large toes, of which the middle is the longest, The slender proximal end of a first metatarsal has been found adherent to the inner face of the second, so that if the hallux was completely developed it was probably very small. No rudiment of the outer toe has been observed.

It is clear, from the manner in which the three principal metatarsals articulate together, that they were very intimately and firmly united, and that a sufficient base for the support of the body was afforded by the spreading out of the phalangeal regions of the toes.

From the great difference in size between the fore and hind limbs, Mantell, and more recently Leidy, have concluded that the *Dinosauria* (at least, *Iguanodon* and *Hadrosaurus*) may have supported themselves, for a longer or shorter period, upon their hind legs. But the discovery made in the Weald, by Mr Beckles, of pairs of large three-toed foot-prints, of such a size and at such a distance apart that it is difficult to believe they can have been made by anything but an *Iguanodon*, lead to the supposition that this vast reptile, and perhaps others of its family, must have walked, temporarily or permanently, upon its hind legs.

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[1] The so-called "coracoid" of *Megalosaurus* is the ilium. I am indebted to Professor Phillips, and to the splendid collection of Megalosaurian remains which he has formed at Oxford, for most important evidence touching this reptile.

However this may be, there can be no doubt that the hind quarters of the *Dinosauria* wonderfully approached those of birds in their general structure, and therefore that these extinct Reptiles were more closely allied to birds than any which now live.

But a single specimen, obtained from those Solenhofen slates, to the accident of whose existence and usefulness in the arts palæontology is so much indebted, affords a still nearer approximation to the "missing link" between reptiles and birds. This is the singular reptile which has been described and named *Compsognathus longipes* by the late Andreas Wagner, and some of the more recondite ornithic affinities of which have been since pointed out by Gegenbaur. Notwithstanding its small size (it was not much more than two feet in length), this reptile must, I think, be placed among, or close to, the *Dinosauria*; but it is still more bird-like than any of the animals which are ordinarily included in that group.

Compsognathus longipes has a light head, with toothed jaws, supported upon a very long and slender neck. The ilia are prolonged in front of and behind the acetabulum. The pubes seem to have been remarkably long and slender (a circumstance which rather favours the interpretation of the so-called "clavicles" of *Iguanodon* as pubes). The fore-limb is very small. The bones of the manus are unfortunately scattered, but only four claws are to be found, so that possibly each manus may have had but two clawed digits.

The hind limb is very large, and disposed as in birds. As in the latter class, the femur is shorter than the tibia, a circumstance in which *Compsognathus* is more ornithic than the ordinary *Dinosauria*.

The proximal division of the tarsus is ankylosed with the tibia, as in birds. In the foot the distal tarsals are not united with the three long and slender metatarsals, which answer to the second, third, and fourth toes. Of the fifth toe there is only a rudimentary metatarsal. The hallux is short, and its metatarsal appears to be deficient at its proximal end.

It is impossible to look at the conformation of this strange reptile and to doubt that it hopped or walked, in an erect or semi-erect position, after the manner of a bird, to which its long neck, slight head, and small anterior limbs must have given it an extraordinary resemblance.

I have now, I hope, redeemed my promise to show that, in past times, birds more like reptiles than any now living, and reptiles more like birds than any now living, did really exist.

But, on the mere doctrine of chances, it would be the height of improbability that the couple of skeletons, each unique of its kind, which have been preserved in those comparatively small beds of

Solenhofen slate, which record the life of a fraction of Mesozoic time, should be the relics, the one of the most reptilian of birds, and the other of the most ornithic of reptiles.

And this conclusion acquires a far greater force when we reflect upon that wonderful evidence of the life of the Triassic age, which is afforded us by the sandstones of Connecticut. It is true that these have yielded neither feathers nor bones; but the creatures which traversed them when they were the sandy beaches of a quiet sea, have left innumerable tracks which are full of instructive suggestion. Many of these tracts are wholly undistinguishable from those of modern birds in form and size; others are gigantic three-toed impressions, like those of the Weald of our own country; others are more like the marks left by existing reptiles or *Amphibia.*

The important truth which these tracks reveal is, that, at the commencement of the Mesozoic epoch, bipedal animals existed which had the feet of birds, and walked in the same erect or semi-erect fashion. These bipeds were either birds or reptiles, or more probably both; and it can hardly be doubted that a lithographic slate of Triassic age would yield birds so much more reptilian than *Archæopteryx*, and reptiles so much more ornithic than *Compsognathus*, as to obliterate completely the gap which they still leave between reptiles and birds.

But if, on tracing the forms of animal life back in time, we meet, as a matter of fact, with reptiles which depart from the general type to become bird-like, until it is by no means difficult to imagine a creature completely intermediate between *Dromæus* and *Compsognathus*, surely there is nothing very wild or illegitimate in the hypothesis that the *phylum* of the class *Aves* has its root in the Dinosaurian reptiles; that these, passing through a series of such modifications as are exhibited in one of their phases by *Compsognathus*, have given rise to the *Ratitæ;* while the *Carinatæ* are still further modifications and differentiations of these last, attaining their highest specialization in the existing world in the Penguins, the Cormorants, the Birds of Prey, the Parrots, and the Song-birds.

However, as many completely differentiated birds in all probability existed even in the Triassic epoch, and as we possess hardly any knowledge of the terrestrial reptiles of that period, it may be regarded as certain that we have no knowledge of the animals which linked Reptiles and Birds together historically and genetically; and that the *Dinosauria*, with *Compsognathus*, *Archæopteryx*, and the struthious Birds, only help us to form a reasonable conception of what these intermediate forms may have been.

In conclusion, I think I have shown cause for the assertion that the facts of Palæontology, so far as Birds and Reptiles are concerned, are not opposed to the doctrine of Evolution, but, on the contrary, are quite such as that doctrine would lead us to expect; for they enable us to form a conception of the manner in which Birds may have been evolved from Reptiles, and thereby justify us in maintaining the superiority of the hypothesis, that birds have been so originated, to all hypotheses which are devoid of an equivalent basis of fact.

[T. H. H.]

II.—Mr. David Forbes on the Study of Chemical Geology.

The Popular Science Review for July contains, among other interesting matter, an excellent article, by Mr. David Forbes, F.R.S., on the Study of Chemical Geology.

The student, writes Mr. Forbes, who now-a-days intends to pursue the science of Geology with any chance of success, must not merely confine his labours to observation in the field, but must necessarily impose upon himself the task of acquiring at the same time a sound fundamental knowledge of the principles of several of the collateral sciences, in order that he may thereby be enabled to understand and estimate correctly, the true value of the evidence he may collect in his travels.

It was, doubtless, very different in the infancy of geology, when the name "geologist was applied to the observer, who, without any pretension to preliminary scientific knowledge, but endowed with a reasonable amount of common sense and a sturdy pair of legs, walked over the district in all directions with a map and section in his hand, upon which he coloured or noted down the relative extent, direction, and inclination of the various rocks which he encountered.

From its very nature, such work is, in great part, merely mechanical in character; and as it is well known that the best maps, whether geographical or geological, are not always the production of those most eminent in the higher branches of the sciences, it is not improbable that the intellectual powers required for the execution of such duties have occasionally been somewhat overrated.

In truth, the very existence of geology itself is dependent upon the co-operation of the allied sciences. Zoology came first to the assistance of the mere stratigrapher, and opened up a new and vast field of enquiry by insisting upon the value of palæontological evidence, and showing how sedimentary deposits, in even the most distant parts of the earth, might be co-related in geological chronology, a result which could never have been arrived at by the mere examination of their mineral character and position in the field; mathematics and astronomy lent their aid in solving many important problems connected with the phenomena of our sphere; and mineralogy was required to determine the mineral components of which its crust was formed; whilst a knowledge of optics and the use of the microscope enables the geologist to extend his investigations far beyond the limits to which his naked eye could otherwise convey him.[1]

When, however, the geologist advances further, and desires to study something more than the mere external forms and physical characters of the materials of which our globe is built up, he is compelled to call in the aid of chemistry, for it is by chemical science alone that he can be enabled to demonstrate the true nature of these materials, to explain their formation or origin, or to discover the causes which have produced the changes or alterations which they have already experienced, or which they may now be undergoing.

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[1] *Vide* "The Microscope in Geology," *Popular Science Review*, vol. vi., Oct. 1867, p. 356, *et seq.*

British geologists seem to have all but exclusively devoted themselves to the consideration of the stratigraphical and palæontological succession of the sedimentary beds, and have, as a rule, studiously avoided the investigation of all geological phenomena which did not appear to admit of explanation by the agency of mere mechanical forces. At the same time, however, it is curious to observe that there have not been wanting those who have put forth vague theories to account for the nature and formation of our metamorphic and eruptive rocks, etc., hypotheses which, unfortunately, can only be regarded as flights of imagination, since it is well known that, with but some few rare exceptions, no chemico-geological investigations or chemical analyses of British rocks or of their component minerals have as yet been made which could serve as a basis for any such generalisations.

Foremost as this country is in all the other departments of geology, Mr. Forbes considers Great Britain to be far behind in Chemical Geology.

The author cautions his readers against the innate tendency to take up a favourite cause or hypothesis, to which is often attributed effects in reality the result of some very different agency, or to the combined action of several causes; the student should, therefore, be particularly careful not to attach himself to any special theory or school of geology which might bias him when estimating the value of evidence brought forward on any question under consideration.

He then proceeds to point out the great importance of a careful definition of the terms igneous, aqueous, and gasolitic action, when applied to the study of geological phenomena.

1. Igneous action is the action of heat as seen developed in active volcanoes, the study of which led to the formation of the Plutonic school of geologists. This is not a mere dry fusion, like melting lead, glass, or other anhydrous substances in a crucible, but is one in which, whilst heat plays the grand *rôle*, is in nature invariably accompanied by the action of the vapour of water and gases.

2. Aqueous action is the action of waters (fresh or saline) such as are seen on the present surface of the globe; and is not the mere solvent action of pure water, but is one in which the air, gases, salts, and other bodies contained in natural waters, assisted by heat, materially alters the solvent powers and chemical reactions of the water itself.

3. Gasolitic action is the effect of gases and vapours, more or less assisted by heat.

All these agencies are naturally modified by the effects of chemical action and mechanical force. In all three cases, the actions of heat, of water, and of gases are found to be combined, each playing a more or less prominent part. Yet there can be no misunderstanding or confusing the precise meaning to be attached to each term.

In igneous or volcanic action, whilst the effects of heat predominate, the presence of heated steam and gases exercises a most important influence in modifying the results: and in this case the water present is in the form of steam.

In aqueous action, on the other hand, the water acts as a liquid, not as a vapour, and is the main agency. Yet the effects of the gaseous and solid constituents, as well as of its temperature, must be taken into full consideration.

The immense volumes of steam emitted by volcanoes during their outbursts, would naturally prepare the observer to expect that some portion might become entangled in the lava, and thus account for the microscopic cavities containing water frequently found in volcanic products; whilst at the same time he would not consider the presence of microscopic water cavities in the older rocks as proving any dissimilarity of origin, or as necessarily demonstrating them to be of aqueous formation, as has been advanced by some writers on the subject.

As an illustration of the fact, that the same phenomenon may at times be the result of totally different agencies, Mr. Forbes takes, for example, the most widely spread of all substances, silica, and shows that it can be produced in the laboratory by many totally distinct processes: as an igneous product by the oxidation of silicon at high temperatures; as an aqueous product by the decomposition of silicates; as a gasolitic product from the decomposition of the gaseous compounds of silicon with fluorine, chlorine, etc.; and it even might be regarded as an organic product, when produced from the decomposition of the silicic ethers.

In the field the chemical geologist meets with abundant cases of crystallised silica or quartz, as an igneous product occurring in the lavas from volcanoes; as an aqueous product crystallised from solution, or proceeding from the decomposition of mineral silicates; as a gasolitic product in the form of tubes, evidently resulting from the decomposition of its fluorine compounds; whilst the carapaces and other parts of infusoria, etc., present silica in a form which owes its appearance to the action of organic life.

Mr. Forbes concludes that it is impossible to be over-cautious in attributing the formation of minerals, or of the rock-masses in which they occur, to any one cause, to the exclusion of other agencies.

He roughly arranges all rocks which are as yet known, under two heads—eruptive and sedimentary; both of which classes of rocks can be subdivided respectively into normal and metamorphic, *i.e.* those which still are found comparatively [1] unchanged, and those which have suffered metamorphism or alteration, brought about by either mechanical or chemical force, or by both combined.

The sedimentary strata, when comparatively unaltered, show themselves as tuffs, ashes, breccias, conglomerates, grits, sandstones, shales, clays, marls, limestones, etc., and have been all formed either by the direct destruction of eruptive rocks or of previous sedimentary beds which, in their turn, had so originated; even the lime which organic life has eliminated from the ocean to form the limestones, came, if not altogether, at least in greater part, from the same source. This has been the case even from the very oldest period, or, in other words, from the epoch of the consolidation of our sphere, since the original crust of the globe must be regarded as representing what may be termed the first eruptive or massive silicated rocks.

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[1] Everything in Nature appears, faster or slower, to become more or less altered.

The study of the chemistry of the eruptive rocks, becomes, therefore, a subject of special interest and importance, not only as tending to elucidate their origin and formation, but also as bearing on the nature of the sedimentary strata which, as before mentioned, have, directly or indirectly, been formed from their ruins.

In Great Britain, it must be acknowledged, there is at this present time, little or no information on this subject in print; and of the few chemical analyses of rocks which have been published, it is to be feared that many of them have been made on specimens which have not been selected with care, so as to represent the actual rock-mass in question; and therefore such analyses, however accurately done, quite misrepresent the composition of the rock-mass as a whole; in fact, a *lithological* analysis is returned where a *petrological* analysis is required.

The terms lithology and petrology are continually misapplied and used for one another, notwithstanding that the difference between them is clearly indicated by their derivations; petrology from the Greek "πέτρος, a rock,"[1] being the study of rock masses *in sitû*, their relations, occurrence, origin, mineral character, physical structure, chemical composition, etc.; whilst, on the other hand, lithology from "λίθος, a stone," is more properly applied to the consideration of stones or detached mineral masses not *in sitû*, blocks, boulders, pebbles, etc., such as are found in drift-gravel, alluvial formations, conglomerates, etc. A knowledge of lithology may be acquired in the cabinet, but petrology must of necessity be studied in the field.

The petrologist, by studying rock-masses on a large scale, discovers simplicity in cases where the lithologist would but eliminate confusion. By a careful examination of the rock *in situ*, assisted by the use of his microscope and laboratory, he comes to the conclusion that all the innumerable rock-species of the lithologist do not exist in nature as rocks, but are mere subordinate portions, altered in appearance or composition by subsequent influences.

Such alterations, or transitions as they are often called, are extremely common at the points of contact of sedimentary with eruptive rocks; thus, for example, a Millstone grit or Carboniferous sandstone may, near the point of contact with an eruptive rock, be found to be lithologically quartzite, similar in appearance to some of even the most ancient quartzites, whilst petrologically considered, it is but sandstone. Again, a micaceous sandstone or a mica-schist bed may, at the point of contact with a felspathic eruptive rock, become in mineral composition a gneiss from the absorption of felspar, yet it is not so petrologically; the petrologist does not base his opinion upon mere hand-specimens, unless in the rare cases where they have been selected with judgment so as to represent the normal rock mass.

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[1] Also πέτρα, whence the synonym Petralogy. In the, for its time, very excellent treatise on rocks—Pinkerton's "Petralogy," 2 vols. London, 1811—the distinction between Lithology and Petralogy is fully explained.

The backward state of petrological knowledge, especially as to the chemical and mineralogical composition of rocks, is in great measure due to the method pursued in its study: in general the field geologist, quite unacquainted with chemistry, and who most probably has never paid any attention even to the difference between petrology and lithology, on encountering a rock in the field knocks off any projecting corner or knob which may fall most convenient to his hammer and sends it to the chemist for analysis. How far a geologist not versed in chemistry may be subsequently able to appreciate and utilise the results of the analysis returned to him by the chemist is open to enquiry; but it may be safely predicted, that, either from proximity to neighbouring rocks of different character, or from the decomposition and alteration produced by atmospheric influences or weathering in all surface-rocks, that hand-specimens so collected are not likely to form the correct representatives of the rock-mass as a whole.

When it is proposed to make a chemical examination of any particular rock, it should first of all be carefully studied in the field, in order that a correct opinion may be formed as to the true nature of the rock-substance itself when uncontaminated or unchanged by external influences; a specimen may then be taken which, in some measure, will represent the actual rock-mass on the large scale, although this is attended with considerable difficulty and trouble, unless (as fortunately in England is generally the case) excavations or quarries have laid bare a face of rock, and so afforded facilities for obtaining the unaltered rock itself.

The quantity required to be taken and pulverised, in order to obtain an average for analysis, must entirely depend upon whether the rock is of a fine or coarse grained texture. In the latter case, a much larger quantity must naturally be employed.

All rock examinations should include a careful description of the mineral constituents of the rock itself, which, if fine-grained or compact, can only be effected by making a section and submitting it to the microscope. The physical properties, as specific gravity, etc., should also be noted, as well as, of course, the relations of the rock to the general geology of its district, and the occurrence of any accessory minerals disseminated in it.

It has been considered necessary to lay great stress upon all points connected with the selection and analysis of rocks, for, if these be not attended to, the labour bestowed upon them may be regarded as entirely thrown away. It cannot but be admitted that the possession of a series of accurate and trustworthy analyses of rocks is of almost vital importance to the advancement of Chemical Geology; and it is sincerely to be hoped that, considering the backward state of our knowledge of this subject in England, some efforts will be made to remedy this defect, and so provide correct data for advancing further research into this promising department of geology.

III.—A. Laganne.—Note sur les Érosions des Calcaires Denudés de la Vallée de la Vézère et de ses Affluents. *Ann. d'Agric., Sci., et Arts, Dordogne.* (? 1868.) (Pp. 8.)

THIS short paper treats of the origin of the many channels that furrow horizontally the limestones of the Valley of the Vézère, etc. These channels have been thought to be the result of old current-action, but M. Laganne shows that they have been formed by atmospheric action, thereby confirming the opinion of M. Lartet, and he thinks that frost is the principal, if not the only, agent employed.

The beds are mostly flat, but sometimes dip in the opposite direction to the flow of the neighbouring stream. In this latter case, if there is a bed susceptible of attack from atmospheric agents, the erosion of the channel follows that bed, and is therefore also in an opposite direction to the stream, whereas if the channel had been caused by current-action, it should clearly slope with the water-flow.

The weathering away of underlying yielding beds has often caused the fall of large masses of overlying firmer rock, and sometimes in places where currents could not possibly have caused such falls.

A means of measuring the rate of atmospheric denudation in the district is given by the occurrence of holes cut in the rock for the support of the rafters of old buildings of known age (about 1435), which were destroyed, exposing the rock in which the holes are cut to be acted on by the weather. Some of these holes are in a rock that does not yield to frost, and therefore are well preserved; others however, were cut in rock that weathers away more or less readily, and these have either wholly or partly disappeared. Assuming that all were once of about the same depth, as is most likely to have been the case, the rate of weathering is calculated to have been about 3-5ths of an inch in 20 years. This is a minimum for these rocks, as atmospheric agents act slowly on the bed in which the above observation was made.

The débris of the limestones form a talus sometimes many metres thick, which, on the current-theory, should have been carried away.

That the channels have not been caused by the chemical action of water, the author thinks is proved by the fact, that no beds of a kind that would result from such decomposition occur in the district. Moreover, chemical action would, he thinks, destroy the débris quicker than the solid rock. [Perhaps M. Laganne undervalues the chemical action of carbonated water, which surely must have had a large share in the wearing away of these limestones].

Lastly, the channels in question occur at all levels, and it is hard to suppose that the waters have been lowered, from the highest levels of the hills to their present level, so insensibly at to leave like traces on all parts of their downward course. W. W.

IV.—On the Light that Geology can throw on some points connected with the Ancient History of the Athenians.

By Albert Gaudry.

[Des lumières que la géologie peut jeter sur quelques points de l'histoire ancienne des Athéniens. Paris, 1867. pp. 32.
Extrait de l'ouvrage intitule—"Animaux fossiles et géologie de l'Attique."]

FOSSIL bones were known to the ancients, and the sight of these remains probably confirmed their belief in the fables of the transformation of living beings into stone. The Greeks had, under their eyes, instances of incrustations produced by the waters of regions composed of marble or compact limestone. Some have thought that the sight of fossil bones would have been regarded by the ancients as indications of the former existence of giants and other monsters. Since, however, it is admitted in our countries that man has been contemporaneous with several animals of extinct species, M. Gaudry inclines towards the opinion that these legends relating to gigantic beings have been based chiefly on the tradition of the animals that have been known in the living state. And it appears to him that the mythological animals of Pikermi have been imagined from a distant remembrance of living animals and not from the fossil bones.

That fossil shells were known to the ancients is, says M. Gaudry, without doubt, and this knowledge, in his belief, led them to adopt certain names for places in conformity with their former configuration, when a sight of these shells led them to such a conclusion; for instance, Peloponnesus (Isle of Pelops) was named for a country which in our days is no longer an island, and probably because the presence of the marine shells in the limestones of this isthmus of Corinth had revealed to them that where the isthmus is placed to-day there was formerly an arm of the sea forming a separation between Peloponnesus and the rest of Greece.

The division of Greece into little states, each possessing an independent position and maintaining a distinct character, resulted from the orographical disposition of the country.

Attica always had an "ungrateful soil." This agricultural poverty results from its geological constitution. Marbles are unfavourable to the development of vegetation; the mountain-chains where these rocks predominate are distinguished by their nudity, owing to the dryness which is due to the force with which they reflect the sun's rays. Travellers who have climbed the white marble mounts well know the burning character of these rocks. Moreover, the vegetable soil gets cemented by the infiltration of water containing bi-carbonate of lime.

The plains or valleys are usually occupied by loose mud and fragments of rocks brought down by torrents, not consolidated, so that the water sinks through and forms subterranean sheets which could furnish spring water.

Attica is well favoured for navigation. The isles of the Archipelago have contributed above all to the prosperity of Greece: they are, perhaps, the fragments of a vast continent which existed during the Miocene epoch; when phenomena of depression marked the commencement of the Pliocene epoch, the lower parts of the continent were invaded by the sea and the higher points remained as islands.

The silver mines of Laurium are of great antiquity and note, but their mineral wealth is said to have been long ago exhausted. Workings are now established at Keratea to obtain the metals left in the refuse from the ancient workings.

The beautiful saccharoid marbles of Pentelicus and Paros have contributed in no small degree to the prosperity of Greece. The purity of the marbles inspired purity of execution. The quarries dug by the ancients are still to be seen, and many facts tend to show how particular they were, and to what expense they must have gone in order to procure the best stone.

M. Gaudry concludes with a few æsthetic and religious sentiments.

H. B. W.

REVIEWS.

I.—The Failure of Geological Attempts made by the Greeks from the Earliest Ages down to the Epoch of Alexander. By Julius Schvarcz, F.G.S., President of the Hungarian Association for the Promotion of National Education, etc., etc. Revised and Enlarged Edition. London: Trübner and Co. 1868. pp. 153, 4to.

DR. SCHVARCZ is well known in Hungary as a scholar of no mean pretensions, and his voice has long been uplifted in his native land in favour of national education. He is also deeply interested in Geology, and in all questions connected with its history from the earliest times.

We are so accustomed to consider Geology as the youngest of all the natural sciences, that we are, for the most part, content to date back its pedigree to the days of Werner, Cuvier, Desmarest, Hutton, Playfair, and William Smith, and to consider the works of earlier writers as belonging rather to the mythical part of its history—just as the Irish, Welsh, and Druidical legends are regarded as compared with the modern history of our own country.

But the childhood of sciences, like that of nations, often affords to the student and historian matter for speculation of no mean interest.

Thus we find in the sacred books of the Hindoos, passages, which, though veiled in poetic or mystic language, seem to indicate considerable advance both in a knowledge of astronomy and physical geology.

The learned too among the Chinese and Egytians, cultivated habits of observation, and noted many changes in the condition of land- and sea-surfaces, and other physical phenomena, which relate more or less directly to natural science.

But even in awarding to these, the most favourable degree of me we must be aware that they possess the very smallest possible title to be considered of scientific value. For history affords abundant proof, that even down to a very late period, the belief in the supernatural so universally prevailed, that, in almost every case, observed facts were so fictitiously recorded as to be utterly valuless as matters of scientific evidence.

Dr Schvarcz has certainly left no stone unturned in order to complete his researches into the state of Geological knowledge amongst the early Greeks. The public libraries of Europe have been diligently searched and every author consulted, lest any omission should occur to mar the completeness of the task. In 1861 he published the result of his researches in the Hungarian language, and afterwards in classical Greek. In 1862 he commenced the work in English, and this year he published the present enlarged and revised edition, which is dedicated to Professor Owen.

The six chapters contain (1), the views of the Greeks as to the etiology of volcanic agency; (2), as to the physical changes now taking place in the earth; (3), as to the changes taking place in the organic world; (4), the physical formation of our earth as understood by the Greeks; (5), their notions as to the origin of the animal and vegetable kingdoms; and how far fossils attracted their attention; (6), in the sixth chapter, the author reviews the amount of knowledge of the natural sciences really arrived at by the Greeks, and their social, political, and religious condition as a nation, which he considers would naturally have so great an influence on the success or failure of the scientific attainments of any nation.

Dr. Schvarcz has arrived at the following results, as expressed in his six chapters—(1) The Greeks were acquainted with all four classes of volcanic action, earthquakes, thermal springs, solfataros volcanos proper: he notices all the authors who have observed and described their phenomena and the theories which were propounded to explain them. (2) The Greeks also observed and investigated the phenomena of alluvial activity. (3) The changes taking place in the organic world did not form a part of the study of the Greeks, for they had arrived at no idea of a "genus" or "species," nor even of the distinctions of Animal and Vegetable Kingdoms. The whole life of the universe appeared to them as the life of an organism, ever fluctuating without any such pivots as the divisions and subdivisions of our modern zoological and botanical classifications. Their idea of the origin of animals was that genesis was not yet finished, but was going on in the days of Pericles, even in the formation of new stars. (4) They knew and understood the real organic origin of fossils; it was only in the time of Aristotle that such remains were attributed to "peculiar species of animals living underground." (5) The doctrine of the gradual degeneration of mankind, common to most Greek sages, may have originated from the misinterpretation of the huge fossil skeletons of Pachyderms, discovered in Greece, and held to be the remains of men of gigantic size. (6) Perhaps the highest idea which seems to have been actually arrived at by Aristarchus in the third century before Christ—if not at a far earlier, *i.e.* Babylonian period[1]—was the Heliocentric idea, that "those stars which do not err, and the sun, remain immovably at rest;" and that "in the circumference (orbit) of a circle the earth is moving around the sun, the latter being placed in the centre of the orbit." To this interesting question Dr. Schvarcz devotes seventeen pages of his very copious Appendix citing all the authorities who have investigated the subject. He condemns those authors of the short-chronology school of Meiners who assert that amongst all the sciences of the earth that of the Greeks is the oldest, and he vigourously supports long-chronology and the researches of Dr. Chwolson in Babylonian literature.

It appears that in deciphering a most ancient work on Nabathean Agriculture the St. Petersburg Professor has not only found records of several stages of Babylonian civilization, which agree with other contemporary long-chronology data, but also evidence of a Babylonian astronomer, Cardana, who had actually calculated lunar tables as early as 2,500 B.C., Babylon itself being a mighty, luxurious, well-organized monarchy, boasting of its own generals, astronomers, statesmen, and sects of philosophers as early as coevally with Dewanai, or 3,000 B.C.!

In resisting the short-chronology arguments, Dr. Schvarcz concludes, "We can no longer submit to such coercive reaction (restriction?) whilst we behold the fossils of Engis, Neanderthal, Bruniquel, Abbeville, and the human remains of St. Prest coëval with the fauna of *Elephas meridionalis* itself" (p. 95).

The Notes at the end of the Appendix render it easy for the scholar to refer to the original authors for every extract given.

Although the Geologist is ever and anon interested by finding a theory only propounded in geological science yesterday,[2] here referred back to the observations of Strato, the natural philosopher, and Xanthus the Lydian, &c., yet we still think, as already stated, that it is to the scholar and historian, *far more* than to the geologist, this work commends itself.

We cannot, however, conclude this notice without expressing our admiration for the author's linguistical and scholarly powers; some passages, especially in Chapter VI., being admirably rendered, and equalling in style the best English composition.

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[1] It appears that Strabo asserted that Seleucus, the demonstrator of the heliocentric idea, was a Babylonian, and that the name of Pitagura (Pythagoras) has been discovered by Dr. Oppert, in cuneiform characters, on an Assyrian inscription.

[2] It behoves our gallant countryman, Col. George Greenwood, to look to his laurels, for, if we mistake not, the Geographer Strabo, 1800 years ago, (or even Strato three centuries earlier) established most satisfactorily the doctrine of "Rain and Rivers!" The shallowing of the Euxine was attributed by Strato to "the numerous large rivers which pour into it from the east and north, and by degrees fill it up with sediment" (p. 98); whilst Strabo observes (p. 101) "it is clear that all the sediment carried down by the rivers into the sea cannot remain in it" (in a state of suspension), but must be thrown out, and join the base of the coast-line. It therefore accumulates, by degrees, in the depth of the shore and forms a low tract of land." Other passages also prove that Strabo quite understood how the delta of the Nile and other large rivers had been formed.

II.—On *Xenacanthus* (*Orthacanthus*) *Dechenii*, Goldfuss.

By Professor Kner, of Vienna.

Reviewed by Dr. Christian Lütken, Assistant Zoologist in the Museum of the University of Copenhagen.

AMONG the many valuable papers by Professor Kner, on Recent and Fossil Fishes,[1] the one before us deserves the particular attention of palæontologists, as giving the first complete elucidation of a remarkable type of fossil fishes, which had been hitherto, to a great degree, misunderstood. Prof. Kner first gives an abstract of the history of his subject. The genera *Orthacanthus* and *Pleuracanthus* were founded 30 years ago (1837), on isolated "ichthyodorulites" from the British Carboniferous System, by Agassiz, and were erroneously regarded as the first indications of the existence of Skates on our planet. They were found in various localities in Great Britain (Dudley, Leeds, North Wales, Carluke, and Edinburgh); and subsequently three other species were described by Dr. Newberry, from the Carboniferous formation of Ohio. A singular form of teeth, considered as those of a peculiar genus of Sharks, *Diplodus*, Ag., was at the same time found in the Carboniferous slates of England (Stafford, Carluke, Burdiehouse), and in Nova Scotia. Ten years later (1847), Goldfuss described and figured[2] a rather well preserved impression of the fish itself from Ruppelsdorf, in Bohemia, while Beyrich (1848), published an account of the counter-part of the same specimen,[3] but named it *Xenacanthus Dechenii*, and Dr. Jordan (1849) described some remains of the same type from Lebach, near Saarbück, as those of a fossil shark, called *Triodus sessilis*.[4] The identity of this last genus with *Xenacanthus* was pointed out by Mr. Schnur.[5]

Meanwhile Sir Philip de M. Grey Egerton, Bart., had pronounced the generic identity of *Pleuracanthus* and *Diplodus* (Brit. Assoc. Glasgow, 1855), and soon after (1857, Annals, vol. xx.), having examined several fine specimens from Klein-Neundorf, in Silesia, he was able to announce that the spines of *Xenacanthus* did not differ generically from these termed *Pleuracanthus*. Up to this time, however, the fish was principally known from Beyrich's description, and was commonly held to be a shark related to the recent *Squatinæ.*

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[1] Kner u. Heckel. Neue Beitrage zur Kenntniss der fossilen Fische, Osterrische, 1861. (Denkschriften d. Wiener Akademie).
Kner u. Steindachner. Neue Beitrage z. K. d. f. F., O. 1863. (*ibid*).
Kner. Ueber einige Fossile Fische aus den Kriede-und Tertiaer schichten von Coman u. Podused. 1863. (Wiener Sitzungberichte).
—— Kleinere Beitrage z. K. d. f. F., O. (*ibid*). 1862.
—— Die Fossilen Fische der Asphaltschiefer von Seefeld in Tirol, 1866. (*ibid*).
—— Die Fische der bituminosen Schiefer v. Raibl in Karnthen. 1866. (*ibid*.)
—— Neuer Beitrage z. K. d. f. F. von Coman b. Gorg., 1867. (*ibid*).
—— Nachtrag. zur der fossilen Fischen von Raibl. 1867. (*ibid*.)
—— Ueber *Orthacanthus Dechenii*, Goldf., oder *Xenacanthus Dechnii*, Beyr., 1867. (*ibid*).

[2] Beitrage z. Fauna d. rheinischen Steinkohle.

[3] Monatsberichte d. Ak. d. W. Berlin.

[4] Leonhard u. Bronn. Jahrbuch, etc., p. 843.

[5] Zeitschrift d. deutschen Geologischen Gesellschaft, viii., 1856.

In 1861 Dr. Geinitz gave a new description and a beautiful figure of it (natural size), in his excellent work on the "Dyas" (pp. 22, 23, f. 1). The discovery, that a remarkable disc-like body, often accompanying the fossil fish, was formed of the coalesced ventral fins, transformed into a sort of sucking-disc, induced this author to place it (with Reichenbach) in the vicinity of the *Discoboli* (Cyclopterines), rather than in that of the *Placoidei.*

Our author then proceeds to describe in detail the various specimens entrusted to his examination by the Museums of Dresden, Berlin, Breslau, and Vienna, and some private gentlemen (Dr. Weiss and Dr Jordan) at Saarbruck, forming together a much richer series of specimens for the investigation of this curious Permian genus, than any of its previous observers had before them. This descriptive portion of Professor Kner's memoir is accompanied by ten lithographic plates. It is hardly possible to give an abstract of it, nor is it necessary, as we may learn from the general sketch given below, of the whole organisation of the animal, in which the author has himself condensed all the most essential results of the preceding elaborate description. If I add that it is no easy task to follow the author through his detailed account of all the more or less fragmentary and often indistinct and dubious specimens, and that the figures do not always aid the understanding of the text, so well as might have been expected, this is not intended as a reproof; I fully understand how very difficult their interpretation and figuring in many instances must have been.

"The general form of the body was elongated, the head broad, rather depressed, the snout broadly rounded, the mandible somewhat prominent, the mouth closely beset with rows of pointed teeth on the inter-, supra-, and infra-maxillaries, the palatine and pharyngeal bones. Most of the teeth were three-pointed, with a short median point and two longer diverging lateral ones that arose from the posterior border of the base, and during repose were laid down in such a manner that only this basilar portion stood forward. They were hollow from the base towards the points, and therefore easily broken; some had a smooth, others a furrowed surface. In the lateral parts of the jaws they were arranged in 28-29 rows of 6-8 in each transversely; on the inter-maxillary they formed 4 rows of 6-8 in each. Beside the tricuspidate teeth, there were perhaps some with one point only,—we suspect that on the pharyngeal bones there were also others with two and four points, or even five and six! The osseous palatine arch appears to have formed, as in sharks, a simple maxillary suspensorium connected with the mandible. The existence and position of the eyes cannot be fully stated, but it is certain that four or five branchial arches were present, armed with a few long rake-shaped teeth: and in the front of these arches numerous thin branchiostegal rays were attached to the distal end of two large bones, answering to the cornua hyoidea. The connexion between the branchial apparatus and the shoulder-girdle is similar to that in the sharks; the scapular arch is not attached to the occiput, but lies further back, as in *Chondropteri* and eels, without any immediate connexion with the vertebræ,—the neurapophyses of eight vertebræ lying between it and the head. There is no vestige of an opercular apparatus. The scapular arch is formed of at least three separate portions,—supra-scapula, scapula, and clavicula. The inferior triangular pharyngeal bone is single, and like the two superior separate ones they are closely covered with teeth of the same kind as those of the jaws; its posterior end lies directly before the scapular arch. From the occiput arises a straight-pointed occipital spine, without any basal articulation, somewhat depressed at the base, rounded towards the point, and serrated on both its lateral margins. The simple-rayed dorsal fin begins before the point of this spine (which is always laid down in a backward direction), and not only runs along the whole back to the point of the long compressed, and rather attenuated tail, but is also continued on the ventral side of the body towards the few-rayed anal fin. The pectorals are inserted at the angles of the scapular arch, and begin with some rather long, broad, bony plates, and a long multi-articulate carpal bone, to which were affixed several oblique, thin, long rays, continued by filamentous fibres, thus recalling the pectorals of the sharks but not specially those of *Squatina*. The anal fin is also distinguished by a strong dichotomous carpal ray. The ventral fins are always situated at, or behind, the centre of the body. and supported by triangular pelvic bones. In some specimens they are coalesced into a ventral disc, and provided inside and behind with tubiform (or half-tubiform) clasping appendages, others are without these, and are separate from each other. The vertebral column runs in a straight line to its extremity, and is composed of numerous vertebral elements, superior and inferior arches with spinous processes, and bearing thin ribs on the anterior arches; the dorsal fin is supported by a double (superior and inferior) row of hollow interspinous and dichotomous accessory interspinal bones (syropophyses, Ag.) articulating with each other, and with the fin-rays by true articulations. The vertebral bodies were nowhere truly developed, and failed in the caudal region altogether. The skeleton was probably mostly cartilaginous, as demonstrated by the distinct impression of the outer mosaic-shaped (tessellated) bony crust, quite similar to that of the living *Chondropteri*. The dermal covering in other examples consisted of a granular shagreen, composed of very small enamelled scales."

For several reasons (especially the difference of the teeth, which are smooth in some, furrowed in others, the different length, shape, and armature of the occipital spine, the dermal covering, etc), the author is inclined to assume the existence of more than one species under the collective name of *X. Decheni*, (the species from Lebach might perhaps be distinct from that of Rakowitz).

The difference in the structure of the ventral fins, Professor Kner most ingeniously interprets (and herein I heartily agree with him), as a *sexual difference*, the ventral disc with its clasping appendages not being a true sucking-disc, as in the *Cyclopteri*, but a male copulative organ. That the *Xenacanthi* fed upon their weaker contemporaries the *Acanthodes*, is evidenced by the discovery of spines and other remains of this genus within the body of the former. As to its geological position, it is characteristic of the "Rothliegende" of the Permian system, and our author thinks that the strata in England and North America containing teeth of *Diplodus* and spines of *Pleuracanthus*, ought, perhaps, on closer examination, also to be referred to the same system, and not to the Carboniferous.

In summing up the characters of this peculiar palæichthyic type with the view of determining its zoological affinities and systematic position, we should, with Dr Kner, distinguish between those which it has in common with modern Chondropterous (Placoid) fishes; for instance, the mosaic or tessellated covering of the skeleton, the absence of opercular bones, the position of the shoulder-girdle, the single undivided suspensorium of the jaw, the articulation of the upper jaw on the lower, the dermal covering, etc., all which of course would indicate the necessity of an arrangement, by which the *Pleuracanthi* would be placed among the *Chondropteri*, in the vicinity of the sharks. On the other hand, there are characters which contradict this position, and which remind us rather of the true osseous fishes; for instance, the dorsal fin-rays, the double row of interspinal bones, the toothed inter-maxillary, palatine, pharyngeal, and branchial arches, the tripartite shoulder-girdle and the branchiostegal rays. Professor Kner thinks these latter arguments so heavy that the balance inclines towards the *Teleostei*, especially the *Siluri*, rather than towards the *Chondropteri*, but that *Xenacanthus* was nevertheless an intermediate form partaking of the characters of each. We must confess, however, that the analogies with the "Sheet"-fishes (Flat-fishes) pointed out by the author; as for instance, the lengthened body, the broad terminal mouth, the shagreen covering of the head, recalling the "helm" of *Bagrus*, the straight and toothed dorsal spine (compressed, however, and serrated before and behind in the "Sheet"-fishes, depressed and serrated laterally in *Xenacanthus*, as pointed out by the author himself, the long many-rayed dorsal fin, continued to or around the long attenuated tail; the appendages of the ventral fins in the males (recalling, however, much more these of the sharks,) appear to us to be only vague analogies rather than evidences of affinity. Even if *Xenacanthus* differed from the *Chondropteri* in all the above-named parts of its organisation, and for some of them we must entirely rely on the sagacity and accuracy of the author, (his figures not always giving convincing proof or the means of checking his evidence,) while others, for instance the branchiostegal rays may be found in Chimæroids. I should think that *Xenacanthus* differed after all not much more from the typical *Chondropteri* (viz., the *Plagiostomi* (Skates and Sharks), though in a different manner and in another direction, than does *e. g.* the *Chimæra*, which is nevertheless commonly and duly regarded as a true Placoid, closely related to Sharks. Might we, perhaps, not come nearest to the truth by establishing in the order of *Chondropteri* a peculiar tribe or sub-order for the exception of the *Pleuracanthini* equivalent to the *Chimærini, Squatini, Raiini,* and *Acanthodini.* There are, perhaps, also some points of relationship between the last-named tribe and another type, verging on the *Teleostei* (*Ganoidei*), but as Professor Huxley has argued, perhaps they are best arranged with the *Chondropteri* and the *Pleuracanthini.* At least I would not advise other naturalists of the Darwinian school, to which Professor Kner evidently belongs, to build too many developmental hypotheses on this somewhat doubtful "*Proto-Silurus.*" I fear there is not strength enough in its back to support them! Whichever opinion as to its systematic position be ultimately adopted, the author's merits are not thereby diminished; he has certainly filled up a hitherto very long-felt vacancy, and Palæichthyology has made a positive advance in the publication of Professor Kner's paper on *Xenacanthus Dechenii*, not on any account to be underrated, and we heartily recommend it to the attention of Zoologists, Palæontologists, and Geologists.

III.—LEONHARD UND GEINITZ'S "NEUES JAHRBUCH FÜR MINERALOGIE, GEOLOGIE, UND PALÄONTOLOGIE." Jahrgang, 1867. Hefte I–V.

THIS excellent monthly periodical of Geology and Mineralogy well supports the reputation it has long possessed as Leonhard and Bronn's Jahrbuch. The original articles are well selected, always of considerable interest and often of great value; the letters to the Editors, with news of fresh discoveries in fossils, minerals, and geological research, are always worth looking at; the catalogue of new books, with a notice of the geological contents of periodicals, is an important bibliographic feature; and the numerous concise and careful abstracts of books, pamphlets, and papers, classified under Mineralogy, Geology, and Palæontology are always acceptable to those who wish to know what is being thought, written, and done in these branches of science.

The five Numbers for the earlier portion of 1867, now before us, supply a fair sample of the result of researches carried on by our German brethren. For Mineralogy, we have *Kenngott* treating of Natrolite (p. 77), and on the alkaline reaction of several minerals (pp. 302–313 and 429–441): zeolites, talc, felspars, augite, mica, spinel, olivine, celestine, chlorite, tourmaline, epidote, etc.; *G. Werner* on the significance of the contours of crystal faces, and their reference to the relations of symmetry in the crystallographic systems (p. 129); at p. 159 *Liebe* gives the particulars of a metallic mineral from Atacama, consisting chiefly of iodine and lead. This "Jodblei" gave, on analysis,—

Antimony	0.77	Iodine	17.01
Carbonic Acid	0.31	Lead	73.01
Sulphate of Lead	5.51		
Chlorine	2.91		99.52

Its origin is suggested as having been due, first to the oxidization of galena, followed by decomposition and rearrangement, arising from the action of alkaline mineral waters carrying iodine. To those geologists in particular, who are looking for distinctive characters in the metamorphosed Laurentian and other old formations, *G. Jensch* offers some facts of interest in his paper on "Garnet, as an essential component of the Gneiss and Gneissite of the Saxon Erzgebirge" (p. 165, etc.). In the true "gneiss" of those mountains ("the older and normal grey gneiss" of Müller), he finds dark mica, albite (tetartine), oligoclase, and rutile (66 per cent. of silica); in the "oligoclase-gneissite" (Müller's "younger grey gneiss") he has dark mica, oligoclase and rutile (65 per cent of silica); in the "tetartine-gneissite" (Müller's "red gneiss") he has clear mica and albite (tetartine), (76 per cent. of silica); in the "granulite," there are clear mica and probably oligoclase (75 per cent. of silica). *F. Sandberger*, at p. 171, offers some remarks supplemental to his paper on "Olivine-rock." *R. Blum* describes some curious drusic concretions from the Bunter Sandstone, near Heidelberg, in which the crystalloids have the form of Calcite crystals, but contain none of that substance (pp. 320, etc.). *E. Stöhr* describes, at large (pp. 403, etc.), the nature, mode of occurrence, and distribution of Kenngott's Pyropissite or Waxcoal, which is found in the Browncoal Formation, near Weissenfels. *H. Credner* (pp. 442, etc.) gives an account of some interesting paragenetic occurrences of gold in Georgia: 1. With garnet and tetradymite in chlorite-schist; 2. With tetradymite in hornblendic gneiss; 3. (crystalline) with mispickel, skorodite, and pharmacosiderite in talcschist; 4. With iron pyrites and limonite in quartz. *H. Fleck* (pp. 291, etc.) treats of the chemical changes in the process of fossilization. At pp. 325, etc., *C. W. C. Fuchs* describes the volcanic phenomena and rocks of Santorin. *Schafhäutl* supplies an additional essay on the rocks and fossils of the Bavarian Alps (pp. 257, etc.), with three outlines of of mountain-crests, and a plate of fossils. One of these ("Diplopora," probably a little *Dactylopora*, as Reuss has shown) was obtained from a morsel of Muschelkalk (?) brought from the highest point of the Zugspitze. *Fr. A. Fallou's* paper on the "Loess of Saxony" (pp. 143, etc.) is of much interest. *A. Stelzner's* translation of *F. Johnstrup's* valuable memoir on the formation and subsequent modifications of the Chalk of Faxoe (pp. 543, etc.) supplies German readers with information, not long since published in Denmark, about the Northern Chalk, which English readers also should have at command. The stratification of the Brown and the Black Jura in the Klettgau, between the Rhine and the Wutach, is given in detail at pp. 39, etc., by *L. Württenberger;* and the age of the limestone of the "Porte-de-France," near Grenoble, is discussed by *E. W. Benecke* at pp. 60, etc., the upper limestone being referred by him to Oppel's "Tithonic" zone, and the lower to the Kimmeridgian. Permian rocks, ores, and fossils receive attention from *Streng* (p. 513), *G. Württenberger* (p. 10), *Geinitz* (p. 288), and *Schmidt* (p. 576); and *Geinitz* also gives an account of the Carboniferous Flora of Portugal, as described by *B. A. Gomes* (pp. 273, etc.); and he figures and describes his *Trybliocrinus Flatheanus* from the Carboniferous rocks of the Asturias; his *Dictyophyton Liebeanum* (?)

from the Culmschiefer, between Gera and Weyda; and his *Trigonocarpus* (?) *Roessleri* from the Lower Permian, near Braunau.

T. R. J.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. May 20th, 1868.—1. "On the Eruption of the Kaimeni of Santorin." By Dr. J. Schmidt. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.R.S., V.P.G.S., &c.

The eruption to which this paper referred commenced in January 1866, and continued uninterruptedly up to the close of the year 1867. Probably years may elapse before the volcanic energy has died out.

The eruption of the Nea-Kaimeni originated on the south side of the island, and extended towards the west. The tendency of the lava current was southwards, and the extension, after about two years, was from 1200 to 1400 yards, and 1800 yards from east to west. On account of the great depth of the water and the continual access of the open sea, the temperature of the water has not been remarkably elevated, varying from 77° to 122° F. The old George harbour has been greatly improved by the upheaval of the southern and western sides, while the channel between Nea and Micra Kaimeni has been shallowed, so as to be passable only for boats.

The author then described the George volcano, and stated that an eruption of stones and ashes, accompanied generally with sharp explosions, took place about every seven minutes. Immediately after these stone-showers, hissing columns of white steam succeeded, and these were followed by faint-yellow noiseless issues from the central fumerole. None of the stones were thrown more than 400 feet above the water. It is impossible to predict anything with regard to the cessation of the eruption, although it has diminished in intensity since 1866.

Discussion.—Capt. Spratt pointed out that this was only one of the many peaks in the large crater of Santorin which have risen up since the historical period. In the position in which he had anchored but six or seven years ago there is now a hill upwards of 300 feet in height.

Sir Roderick Murchison referred to the communications to the French Academy relative to the chemical products of the eruption, and their relation to those of Vesuvius and other volcanoes.

Mr. Forbes directed attention to the fact alluded to in the late President's anniversary address, that the lavas of this volcanic outburst were, at its commencement, trachytes, or of highly silicated character, but afterwards were basic lavas; thus proving that rocks of totally different characters and chemical composition (respectively analogous to the granitic and trappean rocks of former periods) might proceed from a volcanic focus during an eruption.

Prof. Ansted called attention to the probable connexion of the eruptions in these islands and those of Vesuvius and Etna, and mentioned that Baron von Waltershausen had presented to the Society photographs of his magnificent original drawings of the whole region of Etna, which were upon the table, of which only three copies were taken on a larger scale than the published maps.

2. "On the structure of the Crag-beds of Norfolk and Suffolk, with some observations on their Organic remains.—Part II. The Red Crag of Suffolk." By Joseph Prestwich, Esq., F.R.S., F.G.S.

The superposition of the Red Crag to the Coralline having been clearly shown by previous writers, the author confined his paper to those questions on which differences of opinion still exist, namely, the structure of the Red Crag, its affinities with the Coralline, and its exact relation to the Mammaliferous Crag of Norfolk. The Red Crag of Suffolk was described as occupying an excavated area in the Coralline, wrapping round the isolated reefs of the latter, filling up the hollows between them, and occupying a similar, and sometimes a rather lower level than the summits of these older reefs. It forms such an extremely variable series of beds, that the author had been unable to observe any definite order of succession in the greater part of it; but he remarked that oblique lamination is most strongly developed in the lower and central portions, and that almost everywhere there occurs at the base a bed of phosphatic nodules, although deposits of that nature are by no means confined to one level. Old sea-cliffs of Coralline Crag, and remains of old sea-beaches at their base, were described by Mr. Prestwich as occurring at Sutton; and he also gave detailed descriptions of numerous pits in the Red Crag of Suffolk, where the phenomena which he described may be observed. Dividing the Red Crag into an upper, frequently unfossiliferous, member, the fossils of which, being most frequently in the position in which they lived, may be regarded as truly representing the fauna of the period; and a lower fossiliferous portion, in which the shells are found mostly in a broken and comminuted state, and mixed largely with fossils derived from the older Coralline Crag; the author described their distribution in Suffolk, and their mode of occurrence on the eroded Coralline Crag, referring more especially to the difficulty in drawing the line between them in many cases.

In treating of the Organic Remains of the Red Crag, Mr. Prestwich gave lists of the shells found at the different localities, which had been prepared with the aid of Mr. Gwyn Jeffreys. Taking the local conditions into consideration, eliminating the extraneous fossils of the Red Crag of Sutton, Butley, &c., and excluding the freshwater fossils of the more nothern districts, the author regarded the remaining fossils of the two divisions of the Red Crag as being so closely related, that the whole group must palæontologically be treated as one. Mr. Searles Wood had given the total number of species of its Mollusca as 239; to these Mr. Gwyn Jeffreys has added six additional species; on the other hand, he regarded ninety-nine of them as varieties and extraneous fossils, leaving 146 species belonging to the Red Crag. Of these Mr. Jeffreys has identified 133, or 92 per cent., with living species, 115 still being inhabitants of British seas, 15 being found in more northern seas, and 3 in more southern.

From the Mammaliferous Crag of Norfolk and the Red Crag of Suffolk never having been found in superposition, from the circumstance that just at the point where the latter ceases the former begins, as well as from the community of so many species of organic remains, the author regarded the two deposits as equivalent; and he attributed their distinctive characters partly to the extraneous fossils in the Red Crag, and partly to the difference in the conditions which prevailed in the two areas at that time, and especially to the more littoral and brackish-water conditions which prevailed in the Norfolk area. In conclusion, Mr. Prestwich gave a sketch of the physical history of the Red Crag period, describing the mode in which the various phenomena he had noticed had been produced.

Discussion.—The Rev. Mr. Gunn, in opposition to the view of the Forest-bed being placed above the Chillesford-clay, mentioned that at Easton Bavent, where the latter has been supposed to occur in the cliff, he had seen the Forest-bed exposed on the shore. He instanced other cases where the Forest-bed, in his opinion, underlies the Chillesford clay and sands, and supported his views by the evidence of the Mammalian remains of the different beds, and especially the succession of the *Mastodon arvernensis*, the *Elephas meridionalis*, *E. antiquus* and *E. primigenius*. He regretted the absence of any mention of the Mammals of the Red Crag.

Mr. Gwyn Jeffreys made some remarks on the subject of species, and explained how, from a comparison of a large number of specimens, he had in many instances been led to reduce what had formerly been considered as distinct species, into mere varieties of the same species. He corroborated the views of the author as to the presence in the Red Crag of numerous fossils of the Coralline Crag.

Dr. Cobbold stated that, from a microscopic examination of the phosphatic nodules, he had established the existence in them of Radiolariæ and Diatomaceæ, and especially of *Arachnoidiscus coconeis*, the Radiolariæ being chiefly of the division Acanthometræ, all three forms being purely marine.

Mr. Charlesworth commented on the remarkable fact that in a few thousand square feet of Coralline Crag we have a fauna as extensive as the whole British molluscan fauna. He considered that at present the attempt to solve the question of the age of the Red Crag was hopeless, mainly from the difficulty of recognizing extraneous fossils. He expressed his disappointment at the fish-fauna of the Red Crag not having been noticed by the author. The teeth which were common to the Eocene and Red Crag had usually some phosphatic matter adherent. Those, on the contrary, which only occur in the Crag, have never any phosphatic matter attached. He therefore regarded the former class as derivative, but the latter as belonging to the deposit in which they occur.

Mr. Searles Wood, jun., denied that the Red Crag was the one homogeneous deposit divided into two beds as represented by Mr. Prestwich; he protested against the Walton and Butley deposits being regarded as one and the same, the former bearing more affinity to the Coralline Crag, and being, therefore, probably the older.

Mr. Prestwich, in reply, explained that he did not intend to omit the list of mammalian remains of the Red Crag, tables of which were appended to the paper, the greater part of them, however, he regarded as derivative. With regard to the relation of the Chillesford-beds to the Forest-bed, he had never *seen* a section in which the latter was found beneath the former—the Chillesford beds at Easton Bavent were underlain by sandy beds referable to the Norwich Crag. He considered that some division in the lower bed, as suggested by Mr. Searles Wood, was to be found.

II. June 3rd, 1868.—1. "On some Genera of Carboniferous Corals." By James Thomson, Esq. Communicated by Dr. P. Martin Duncan, Sec. G. S., etc.

Mr. Thomson gave a *resumé* of the diagnostic peculiarities of *Cyathophyllum*, Goldfuss, *Clisiophyllum*, Dana, *Aulophyllum*, Milne-Edwards and Jules Haime, and *Cyclophyllum*, Duncan and Thomson. The author then noticed that the separation of these genera was inevitable and necessary, from the ordinary rules of the classification of the *Zoantharia*. He concluded by remarking upon the evident structural distinctions between *Clisiophyllum*, *Aulophyllum*, and *Cyclophyllum*.

Discussion.—Dr. Duncan said that the existence of a columella was a generic distinction in Recent and Mesozoic corals, that the type of the Palæozoic Cyathophyllidæ was reflected in the Lower Liassic coral-fauna of South Wales and the west of England, and that there was a necessity for the same principles of classification in the Palæozoic and in the Recent coral-fauna. There was a gradation from the Rugosa to the Aporosa.

Prof. Huxley remarked that the structures of the specimens of the different genera proved that there were great difficulties in accepting Agassiz's opinion that these old forms were not *Zoantharia*.

2. "On the Pebble-beds of Middlesex, Essex, and Herts." By S. V. Wood, Jun., Esq., F.G.S.

The author described two groups of pebble-beds. The first of these, composed of rolled flint only, and confined to the outliers of Bagshot sand scattered through Middlesex and Essex, he considered must be referred to the deposit of the Bagshot sea during its recession from these counties; unless the Lenham beds could be held to establish the existence of an older Pliocene sea over Kent, in which case this group of pebble beds might be connected with that event. The second group of pebble beds was the same as that lately described by Mr. Hughes in Hertfordshire, as "gravel of the higher plain" of that county, which is found intermittingly to underlie the Glacial clay at high levels. Mr. Wood objected to Mr. Hughes' view that this bed was anterior to the gravel of the lower Hertfordshire plain (which is of Middle Glacial age and underlies the Glacial clay at lower levels); regarding it as merely a modification of the latter at the close of the Middle Glacial period, due to much of it having been, at these high levels, constructed out of the pebble beds of the first described group.

Discussion.—Mr. Prestwich was inclined to regard some of the beds referred by the author to the Bagshot series rather as local drifts, derived mainly from those beds, than as the beds themselves.

Mr. Whitaker saw a difficulty in classing the pebble-beds at Brentwood and elsewhere among the Bagshot beds, as in the London district, at all events no such pebble-beds occur in the Bagshot series.

Mr. Evans pointed out the difficulty in supposing that the gravels at the high level could have been deposited at a later period than those of the low level without, at the same time, overlying the latter.

Mr. Searles Wood considered that there was not that broad line of distinction to be drawn between the gravels of the higher and lower level; he maintained that the pebble-beds when truly in situ were free from Quartzite. and truly of the Bagshot age.

3. "On the Cretaceous Rocks of the Bas-Boulonnais." By William Topley, Esq., F.G.S., of the Geological Survey of England and Wales.

After a *résumé* of previous notices on the subject, the author described the Physical Geography of the district and the Cretaceous beds below the Chalk, comparing them with their English equivalents.

Each great division of the Kentish series was stated to be represented in the Boulonnais, although in every case, in diminished thickness. The Upper Greensand and Gault were shown to surround the district at the base of the Chalk hills; and a fossiliferous phosphatic bed was described at the bottom of the Gault, as in Kent. This bed was regarded by the author as a passage between Gault and Lower Greensand, as nodules with fossils often occur in the sands below; and it was shown to be frequently impossible in sections to mark off accurately the Lower Greensand from the Gault. The marked change in the fauna of these formations was regarded by the author as due to the complete change in the conditions of deposit.

The sands which occur below the Gault were shown to belong partly to the Folkestone beds (or highest division of the Lower Greensand) and partly to the Wealden—the intermediate stages being absent, although well developed where last seen on the Kentish coast. The ferruginous sands, with variegated clays and iron-ore, which cap the hills in the interior of the Bas-Boulonnais, were referred by the author to the Wealden series, as were also the pebble-beds of St. Etienne and elsewhere, hitherto regarded as "drift."

The Wealden beds were shown to rest upon the Portlandian around Boulogne, and upon lower members of the Oolites in the west and north; while in the north-west corner they fill "pipes" in Palæozoic limestones. The Wealden beds, thus proved to be unconformable to those below them, were shown to underlie conformably the remaining Cretaceous beds above, thinning away, however, against the old ridge, where, by overlapping, the Lower Greensand and finally the Gault, rest immediately upon the Palæozoic rocks.

The paper was illustrated by a map, showing the probable outcrop of the Cretaceous rocks beneath the English Channel.

Discussion.—Sir Roderick Murchison, without doubting the correctness of the author's views, wished that fossil evidence had been forthcoming to identify more conclusively the Wealden strata of the Boulonnais with those of England, and suggested their correlation with the Beauvis beds.

The Rev. Mr. Wiltshire remarked that in Kent the *Ammonites mammillaris* was contained in large nodules, and occurred only below the lower phosphatic band.

Mr. Whitaker, who had been with the author in the Boulonnais, had been, contrary to his predilections, compelled to regard the beds referred to the Wealden as belonging to that formation, and not to the Lower Greensand.

4. "Note on the Mendip Anticlinal." By C. H. Weston, Esq., F.G.S.

The author called attention to the discovery of igneous rocks in the north-western portion of the Mendip Hills long previous to Mr. Moore's discovery of them in the south-east: and he stated that this fact left no doubt about the persistence of this upheaving agent throughout the entire anticlinal of the Old Red and Carboniferous series.

III.—June 17th, 1868.—1. "On the Distribution of Stone Implements in Southern India." By R. Bruce Foote, Esq., of the Geological Survey of India.

The chipped stone implements of Southern India are found in, or associated with, two formations—the coast-laterite, which is a marine formation, and a freshwater deposit, occurring inland at greater elevations above the sea. Most of them have been found either *in situ* in the laterite of the eastern coast, or distributed over its surface; several have been collected off the surface of older rocks, in places where the laterite had been removed by denudation; others have been discovered on the surface at great elevations in other parts of the country, where no distinct traces could be seen of the formation from which they had weathered out, and which had a different origin (possibly freshwater) from that of the marine coast-laterite; while a few have been obtained from unquestionably fluviatile deposits. None have been collected from formations known to be either younger or older than the coast-laterite.

The author inferred that during the latter part of the laterite-period the land was raised to the extent of 500 or 600 feet; that this elevation was followed by a period of quiescence, during which the laterite was extensively denuded; that this epoch was succeeded by a period of depression, during which the recent coast-alluvium was formed; and that a subsequent elevation brought the land into its present position.

Discussion.—The President referred to the evidence of Physical Geography to prove that the Deccan was once an island, and to Ethnological data to prove that the people who made the quartzite implements were probably not the original Aryans, but were the ancestors of the Hill tribes, whose nearest affinities are with the aboriginal Australians of the present day. He was of opinion that the two populations were once nearly or quite continuous, having been subsequently cut into segments by geological changes; and that the makers of the quartzite implements came from the same stock as both the recent tribes, which present the most rudimentary civilization known.

Professor Rupert Jones called attention to the similarity in the type of these quartzite implements and that of the flint implements of Europe.

Sir Roderick Murchison doubted whether the laterite was a marine formation, as neither in it nor in the lacustrine deposits alluded to had any organic remains been found.

M. de Normand stated that Obsidian knives, like Mexican types, were found by him, with domestic implements cut out of volcanic stone, under 70 feet of tuff of the primitive volcano of Santorin; and he considered that before the formation of the first volcano Ceramic pottery was brought to Santorin from foreign shores, and, of course, by sea.

Dr. Meryon remarked that the occurrence of the same type of implement in Europe and Asia proved a dispersion of the human race in very ancient times, and that man originated from one centre; while in later times a divergence of type in the worked objects was a result of the dispersion.

Mr Prestwich was inclined to believe that greater physical changes had occurred in India since the Pliocene period than in Europe. The implements were so like those of Europe, that their fabricators seemed to have been taught in the same school.

Mr Foote, in reply, stated that he regarded the laterite as a marine formation, because it occurred all round the coast. All the implements were quartzite, with perhaps one doubtful exception, which was formed of basalt. Stone circles and kistvaens had been found on the surface of the laterite in some localities.

2. "On worked Flint flakes from Carrickfergus and Larne." By G. V. du Noyer, Esq. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.G.S., etc.

These flakes have been found by the author in two very distinct positions, namely, the older in the marine drift (sand and gravel) skirting the shores of the county Antrim and the county Down, the maximum elevation being about 20 feet above the sea; and the more recent in the subsoil clay at all elevations up to [illegible] feet, near Belfast, Carrickfergus, Larne Lough, and Island Magee. The former are of the rudest forms, highly oxidized or white on their entire surface; but, though imbedded in marine drift, having the chippings around the sides and angles generally sharp. The latter have a comparatively fresh look, though still possessing the characteristic porcellanous glaze; they are regarded by Mr. Du Noyer as possibly the rough materials out of which the historic races in Ireland manufactured the spear and arrow-heads which are found with their sepulchral and other remains.

3. "On the Diminution in the volume of the Sea during past Geological Epochs." By Andrew Murray, Esq., F.L.S. Communicated by the President.

In opposition to Sir Charles Lyell, the author submitted that instead of the proportion of dry land to sea having always been the [illegible]ne, and its volume above the level of the sea a constant quantity, [illegible] are constantly increasing, while both the mean and extreme [illegible]hs of the sea are constantly diminishing, the cause being the [illegible]me affinity which water has for the constituent elements of [illegible]rals. In illustration of his view, he quoted the so-called up[illegible]val of coral-islands as being really caused by a diminution in the [illegible]ume of the sea.

4. "Has the Asiatic Elephant been found in a fossil state?" [illegible]y A. Leith Adams, M.B., F.G.S. With a Note by G. Busk, Esq., [illegible].R.S., F.G.S.

An elephant's tooth in the possession of Dr. Fischer, of St. John, [illegible]ew Brunswick, which had been found in Japan at a distance of [illegible]rty miles from the sea-shore, between Kanagawa and Jeddo, and at the base of a surface coal-bed, appeared to the author referable to the Asiatic elephant; and he accompanied his description of it by a drawing and plaster cast. In his note appended to the paper, Mr. Busk gave some further details of the characters exhibited by the cast, and agreed with Dr. Leith Adams in regarding it as probably referable to *Elephas indicus* rather than *E. Armeniacus*, a fossil molar of which had been found in China; but he concluded that it was the *antepenultimnte* upper left molar, and not the *penultimate*, as inferred by Dr. Leith Adams.

5. "On the Characters of some new Fossil Fish from the Lias of Lyme Regis." By Sir Philip de M. Grey Egerton, Bart., M.P., F.R.S., F.G.S.

The species described in this paper were the following:—

Osteorachis macrocephalus, gen. et spec. nov.—A Sauroid fish, chiefly remarkable for the massive dimensions and complete ossification of the bodies of the vertebræ, and characterized by the large size of the head and the multiplicity of the teeth.

Isocolum granulatum, gen. et spec. nov.—For elegance of form this fish can vie with the salmon of modern times, its contour being very similar. It bears the greatest resemblance to the Sauroid genus *Caturus*, but in the absence of the teeth it cannot be assigned with certainty to any particular family.

Holophagus gulo, spec. nov.—A Cælacanth fish, remarkable for its resemblance, especially in the contour of the head, to the Cretaceous genus *Macropoma*, and for substantiating Prof. Huxley's demonstration of the persistence of type presented by this family, which ranged from the Coal-measures to the Chalk.

Eulepidotus sauroides, gen. et spec. nov.—This fish represents a genus uniting the Lepidoid and Sauroid families of Agassiz's Ganoid order; the teeth and the tail being Sauroid in character, while the fins are Lepidoid, and the scales partake of the characters of those structures in both families.

6. "Note on the Geology of Port Santa Cruz, Patagonia." By Capt. T. Baker, Lieut. Royal Naval Reserve. Communicated by the Assistant-Secretary.

This note accompanied some specimens of fossil shells obtained by the author from the cliffs of the western arm of the River Santa

Cruz, the stratification of which he described. The shells are for the most part referable to the Tertiary species from Patagonia previously obtained by Mr. Darwin.

7. "On the Jurassic deposits in the N.W. Himalaya." By Dr. F. Stoliczka, F.G.S., of the Geological Survey of India.

The author described the following strata as composing the Jurassic rocks in the north-west Himalayas:—

1. Lias { *a.* Lower Tagling limestone.
  { *b.* Upper Tagling limestone.
2. Dogger { *c.* Jurassic slates.
  { *d.* Spiti shales.
3. Malm ? *e.* Gieumal sandstone.

The object of the paper was to show, in opposition to Mr. Tate's assertion to the contrary, that the Indian Jurassic formation could clearly be subdivided, and that in some measure the subdivisions correspond with those of the European Jura.

8. "On a true Coal-plant (*Lepidodendron*) from Sinai." By J. W. Salter, Esq., A.L.S., F.G.S.

The fossil described was received by Sir R. I. Murchison some years ago. The author regarded it as an infallible indication of the presence of the true northern Coal-formation, with species like those from the Erekli coal. The proposed name of the species is *Lepidodendron mosaicum*.

[*The Abstract of the remaining papers read at this meeting will appear in the September Number.*]

WOOLHOPE NATURALISTS' FIELD-CLUB.—On Friday, June 19th, the Woolhope Naturalists' Field-club held their second meeting for the season at Crumlin and Pontypool. They were largely reinforced by a detachment from the Cardiff Natural History Society, which commenced its campaign for the first time under the presidency of Mr. Adams, F.G.S. Headed by Dr. McCullough, the President of the Woolhope Club, the party first of all inspected the Crumlin Viaduct, by which the Great Western Railway is carried over the gorge of the Ebbw valley at a height of 210 ft., and then ascended Llanhilleth Hill, at the summit of which (about 1600 ft.), commanding a wide panorama, Mr. G. Phillips Bevan, F.G.S., delivered to the assembled members an address on the South Wales Coalfield, in which he called attention to its former continuity with other coalfields, and also to the various geological conditions which had taken place in the history of the basin, and which he briefly summed up as follows:—1. Deposition of the Lower Measures; 2. Their subsidence; 3. Occurrence of westerly force; 4. Deposition of Upper Measures; 5. Gradual uplifting; 6. Denudation. From Llanhilleth Hill the party moved off through the lovely glen of Cwmffrwyd, where the botanists found some rare mosses, and arrived at Pontypool to dinner, under the presidency of Dr. McCullough. After dinner, a paper was read by Dr. Rankine on "The Flight of Birds," and another by Mr. Elmes Steel on "Mason Wasps and their habits." Mr. Bevan was elected an honorary member of the Woolhope Club. The weather was magnificent, and the day was greatly enjoyed by both clubs.

CORRESPONDENCE.

DISCOVERY OF A PLEISTOCENE FRESH-WATER DEPOSIT, WITH SHELLS, AT HIGHBURY NEW PARK, NEAR STOKE NEWINGTON.

Sir,—Some of your readers may be interested in the discovery made to-day by me of fossil shells, of the ordinary Thames Valley pecies, in the more eastern of the two brick-pits in Highbury New Park.

The older and more western of these pits has been open for 20 years; but although it possessed well-marked and stratified beds of deep purple clays containing much wood, almost in a recent condition, yet no fossil shells have been discovered. The surface of the ground at the western brick-pit is 120 feet above the Ordnance datum-line. At a depth of 40 feet in this pit the yellow sands are well seen at the present time, false-bedded, 10 feet in thickness, and in many respects like the Cyrena-sands at Crayford, but, unfortunately, up to the present time no fossils have been found there. The surface of the ground at the newer and more eastern of the two pits in Highbury New Park, containing the newly discovered shell-bed, is 102 feet above the Ordnance datum-line. The clay-bed, 2 feet thick, and full of land and freshwater shells, accompanied by much wood, is 22 feet below the surface, and consequently 80 feet above the Ordnance datum-line. There are also some shells in the reddish loam or brick-earth, immediately above the clay, so that the Thames Valley fossiliferous beds reach at this point to 85 feet above the Datum. The London Clay surface is supposed to be 10 feet below the shell-bed.

At 750 yards to the north of this brick-pit the Hackney Brook formerly flowed, at a height of 75 feet, on a bare surface of London Clay.

At 530 yards due west of this pit the ground in Highbury Park is 142 feet high, and the London Clay reaches to within 5 feet of the surface, and is covered with coarse gravel, without any brick-earth.

The thick brick-earth series intercalated with gravel, sand, and clay beds on the Highbury New Park, therefore, probably owes its formation and preservation to the protecting influence of this high escarpment of London Clay. I have shown the importance of these escarpments, and their relation to the Thames Valley deposits, in papers read before the Geological Society.

Mr. R. Tate has kindly examined the fossils collected in the Highbury New Park pit, and gives the following list and remarks:

"Land Shells.—*Helix rufescens, var. depressa,*
Zua lubrica,
Clausilia biplicata,
Succinea putris,
Carychium minimum.

"Fresh-water Shells.—*Limnæa palustris,*
Planorbis marginatus,
,, *spirorbis,*
Valvata cristata,
Valvata piscinalis,
Pisidium obtusale,
,, *pusillum.*
Cyclas cornea, var.

"The above assemblage of species suggests a shallow pool or a slow running stream of slight depth, on the margins of which semi-aquatic plants grew, affording shelter for the land snails, which inhabit usually marshy or damp situations; *Zua lubrica*, however, is more sylvan in its habits, than the others. All the species inhabit Great Britain, but *Clausilia biplicata* ranks amongst our rarest.—R.T.

In 1866, during the formation of a cutting through Hackney Downs, Mr. S. Skertchly made a large collection of Thames Valley drift-shells which he discovered there, and brought me a series which were named by Mr. R. Tate. I understand Mr. Skertchly also sent a set of specimens to Mr. Smith at the same time. In July, 1867, a notice of the discovery of these shells appeared in the *Natural History Repertory*, by Mr. George J. Smith. I inspected the section in 1866, and found that the Unios were in a bed of purple clay with sands above and below them. The surface of Hackney Down is 70ft. above the Ordnance datum-line, and the Cyrena and Unio bed, although partly covered up when I examined it in 1866, appeared to be, at least, 20ft. below the surface. The Hackney Brook formerly flowed 550 yards west of the above Cyrena bed on Hackney Down at a height of 51 feet above the Ordnance datum-line. I consider that in this part of its course the channel of Hackney Brook was on this same Pleistocene clay, which is three or four feet thick, and not in London Clay, as marked in Mr. R. W. Mylne's Map of London.

The discovery at Hackney Downs of a clay-bed with shells reminds us of the description of a similar section at Shacklewell by Mr. Prestwich in Vol. XI. of the *Quarterly Journal of the Geological Society*, at a locality not far distant from Hackney Downs. The clay-bed is described there to be between beds of sand; but neither Cyrena nor Unio are in Mr. Prestwich's list of fossils from that excavation. Sir C. Lyell, however, states in the "Antiquity of Man," that he had seen Cyrena at Shacklewell, page 161.

Cyrena and Unio are found together in great abundance at Grays, Crayford, and Hackney Downs. Mr. A. Harris, of Bradford, brought me, in 1867, a number of specimens of the same Cyrena, accompanied by an undescribed but remarkable species of Unio from a Pleistocene gravel 150ft. above the present Nile, and 1200 miles from the Mediterranean. I use the name Cyrena as more familiar than the term *Corbicula*, by which it is often recorded.

I should hope that shells may yet be found in the larger and older brick-pit in Highbury. The smaller brick-pit in Highbury New Park is easily found, as it is about one hundred yards west of the bridge over the New River in the Green Lanes, Stoke Newington, close to Aden Terrace, and about four hundred yards east of Highbury Barn Tavern. No doubt a considerable addition might be made to the number of species collected by me, and it is therefore very desirable that the spot should be carefully examined before it is filled up.—

ALFRED TYLOR.

STOKE NEWINGTON, *July 5*, 1868.

THE
GEOLOGICAL MAGAZINE.

No. LI.—SEPTEMBER, 1868.

ORIGINAL ARTICLES.

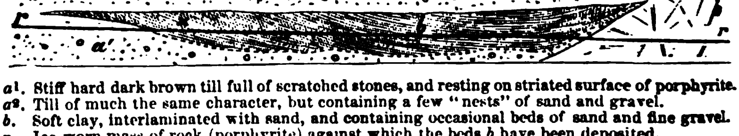
I.—NOTE ON THE DISCOVERY OF *BOS PRIMIGENIUS* IN THE LOWER BOULDER-CLAY OF SCOTLAND.

By JAMES GEIKIE, F.G.S., ETC.

IT will interest some of your readers to hear that remains of *Bos primigenius* have recently been obtained from the true till or lower Boulder-clay of Scotland. The specimens hitherto found appear to have come either from the fine Glacial brick-clays, which are posterior in date to the larger portion of our Boulder-clay, or from deposits of still later age. A few days ago I heard that the navvies employed in making the new "Crofthead and Kilmarnock Extension Railway" had come upon what was described to me as a "wonderful big bull's head." I lost no time in visiting the locality, and saw the fossil in the possession of Mr. John Strain, C.E., who allowed me to examine it, and was afterwards kind enough to accompany me to the railway cutting in order to point out the exact spot from which the relic was taken. The skull is in rather an imperfect state, and only one of the horn-cores remains, the other having been broken off near the base. The perfect core measures 31 inches in length along the outer curve, and gives at its base a circumference of 14 inches. The breadth of the forehead between the horns is 10 inches. From the character of the flat forehead, from the origin of the cores, and from the direction and curvature of the remaining one, there can be no doubt that the skull is that of *Bos primigenius*. The fossil was imbedded some few feet deep in a soft clay or mud, interlaminated with lines and beds of sand, and occasional layers of fine gravel. In some of the layers of clay, I detected a little vegetable matter, but in such a state of decay, that I could not be certain as to the character of the plant. It appeared to resemble the fibres of some heath. These beds occupy a basin-shaped depression, and rest partly on Boulder-clay and partly on rock. I do not know how thick they may be towards the centre of the trough, for the cutting has not been carried down to the rock or Boulder-clay; but, at least, from 10 to 15 feet of stratified materials are there exposed, and the total thickness is probably as much again. The strata are overlaid by Boulder-clay in such a way as to leave no doubt on the mind that they form an intercalated series. I was particularly careful to ascertain whether a slip from the hill-side might not explain their interstratified position; but after a minute examination, I was satisfied that no such land-slip had taken place, but that, as I have shown in the sketch-sections, the laminated clay and sand are distinctly interbedded with the till. This till is a stiff, hard, dark-brown clay, full of scratched stones, and rests on a much grooved and well-polished surface of porphyrite,—the striæ running parallel with and up the valley, *i.e.* to the south-west. The stones have travelled no great distance, but here and there, one may detect a fragment of mica schist, gneiss, quartz-rock, and Old Red Sandstone—showing that the moraine matter has been amassed during the passage of the glacier from north to south. I noticed no material difference between the till which overlies and that which is overlaid by the stratified deposits. The former contains a few lenticular nests of earthy sand and gravel, which I did not observe in the latter; but there is not so much of this last exposed; and, moreover, as geologists know, the occurrence of such "nests" is common enough in the Scottish lower Boulder-clay.

The valley in which these deposits are met with is a remarkable one in its way. The denuding forces which scooped it out have acted along the line of a large fault bearing S.W. to N.E., and consequently the narrow hollow extends in a nearly straight direction from the neighbourhood of Caldwell-house to Barrhead, a manufacturing place, about eight miles south-west from Glasgow. The southern end of the hollow is partly occupied by a small lake (Loch Libo), now much reduced in size as may be seen from the extent of the surrounding alluvium, and the water drains towards the south into the Lugton. But from Shillford (a toll-bar about half-way between Caldwell and Crofthead) the water drains to the north. It was in this northern division of the hollow, in the valley of the Cowdon Burn, near the farm-steading of Millthird, at a height of nearly 500 feet above the sea, where the remains of the *Bos primigenius* were found.

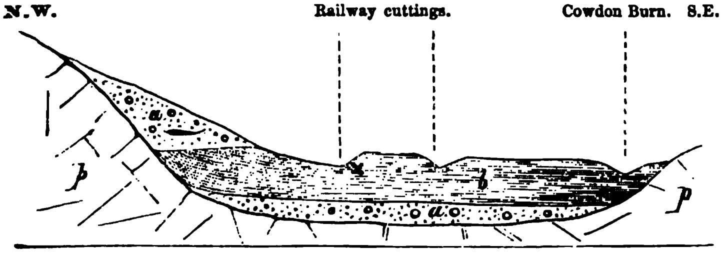
Fig. 1. Sketch-section exposed in the new railway-cutting near Crofthead, Renfrewshire.



*a*¹. Stiff hard dark brown till full of scratched stones, and resting on striated surface of porphyrite.
*a*². Till of much the same character, but containing a few "nests" of sand and gravel.
b. Soft clay, interlaminated with sand, and containing occasional beds of sand and fine gravel.
p. Ice-worn mass of rock (porphyrite) against which the beds *b* have been deposited.
×. Position of the skull of *Bos primigenius*.
r. Present level of railway cutting.

The sketch-section (Fig. 1) is that which was laid bare at the time I visited the cutting; of course it runs parallel with the valley. The succession of events, as I read it, is as follows:—First, a glacier ascends the valley, polishing and striating the underlying rocks, and eventually covering them over with its moraine profonde. I need scarcely add that this glacier formed only a portion of the great sea of ice which mantled the land during the early stages of the Glacial period. The glacier then disappears, and behind a large ice-worn mass of rock (*p*) which rises in the centre of the valley, a little lake is formed. Into this lake the *Bos primigenius* is floated by stream or freshet. As the till further up the valley towards Shillford continues to exhibit intercalated beds of sand, clay, and gravel, I am led to infer that either one large lake with a very uneven bottom, or more probably a series of small lakes, may once have occupied the area between Caldwell and the spot where the fossil remains of the great ox were obtained. When the glacier again ascended the valley, it spread its moraine profonde over the surface of the deposits which had accumulated in the lake or lakes. The slight twisting and confusion of the bedding observable in some places is perhaps due to the pressure exercised by the moving ice. The junction of the stratified beds with the overlying till is very regular, however, and forms nearly a straight line, as shown in the woodcut. But anomalies such as this are not of unfrequent occurrence in the lower Boulder-clay.

Fig. 2. Diagrammatic section across the Cowdon valley, near Crofthead.



a. Lower Boulder-clay. *b*. Stratified clay, sand, and gravel.
×. Position of *Bos primigenius*. *p*. Porphyrite.

I give here a diagrammatic section across the valley, showing the position of the drifts, as they were to be seen at the time of my visit; but as the navvies are busily digging away at the deposit, the section will not long remain in the same condition, and in due time will no doubt be rendered as illegible as orthodox railway-cuttings usually are.

II.—Notes on Modern Chemistry and Physics.

By Bernard H. Woodward.

If any apology be needed for the introduction of these notes in the pages of the Geological Magazine, the excuse we would give is that geologists are, at the present time, being reproached, and perhaps deservedly, for attempting to generalize in cases which, to a great extent, depend upon chemical and physical actions, without having given these sciences that amount of study and consideration which their vast importance merits.

Our object is, therefore, to endeavour to attract the attention of the readers of this Journal to what is going on in these departments of science, and thus, perhaps, to induce them to devote a little time to the perusal of those works which treat of the modes of action, and correlation of the physical forces, the result of the researches of Joule, Mayer, Faraday, Grove, Tyndall, Herschell, Whewell, Becquerel, Sorby, and others, who have devoted their lives to the investigation of these great problems.

During the last few years our ideas *de rerum naturâ* have altered very considerably, indeed, have undergone a complete revolution. Through the researches of modern chemists the barrier separating inorganic from organic chemistry has been annihilated.

In a comparatively recent chemical text-book, we find it stated that "organic chemical compounds are those directly or indirectly derivable from organized bodies. They cannot, except in very rare instances (*e.g.* urea and cyanogen), be formed by bringing their elements together, but must either be derived *ready-made* from plants and animals, or must be prepared from such *ready-made* substances." And it gives us examples of these organic bodies, sugar, alcohol, and acetic acid, stating that, although we know that all these are composed of but three elements, namely, carbon, hydrogen, and oxygen, in different proportions, "yet we cannot, in the laboratory, unite these three elements so as to form either of the above compounds, though we can obtain the two latter from the first by fermentation or chemical action."

It was then supposed that the elements of these organic compounds could only be built up in these proportions through the agency of "vital force."

Now sugar, alcohol, and acetic acid can be produced synthetically, *i.e.* can be built up by the direct combination of their elements.

It is found that, at a very high temperature, carbon will combine with hydrogen, producing acetylene. This is effected by producing the voltaic arc between carbon-points in an atmosphere of hydrogen, (by means of a very powerful battery), whereby the most intense heat with which we are acquainted is obtained.

By treating this acetylene with a copper salt, cuprous acetylide is formed; from the latter, by means of nascent hydrogen, ethylene is generated, and, by acting on ethylene with sulphuric acid, alcohol is produced. From alcohol it is easy enough to get, by chemical action, acetic acid.

Thus we have traced out the formation of two of the best known of the so-called organic compounds from their ultimate elements, simply by the action of heat, and the aid of compounds, like sulphuric acid, that have never had the slightest claim to be considered organic.

Acetic acid can also be formed from the carbonic disulphide, and starting with the acetylene before produced; but, acting on it with other reagents, succinic and tartaric acids, also benzol can be obtained, from which, by easy steps, we reach aniline and toluidine, the bases of the coal-tar colours.

If it were desirable we might easily extend our list of the substances formerly considered to be organic, but which we can now form directly from their elements; but we think the instances given above are sufficient to prove that there is no natural barrier between inorganic and organic compounds. This, it is needless to add, brings us no nearer to the cause of life; chemistry only deals with the combinations of matter.

We use here the term "organic chemistry" in its old sense, *i.e.* the chemistry of organic life as distinguished from "inorganic" or "mineral chemistry." Since these discoveries the term organic chemistry is more generally applied to the chemistry of carbon and its compounds.

The syntheses, of which we have given a brief sketch above, are chiefly the results of the investigations of the chemists of this generation. In such a short notice it would be invidious to mention names. For a more detailed account we would refer our readers to the report of a lecture by Mr. Greville Williams, F.R.S., delivered at the Royal Institution on the 8th of May last, on the "Artificial Formation of Organic Substances."

In physical science also, of late, the changes in our conception of the nature and mode of action of the physical forces have been very considerable. Attraction, motion, heat, light, electricity, magnetism, and chemical affinity, are now all considered to be *affections* of matter itself, not specific entities, as was formerly supposed; they are sometimes called modes of motion, being all resolvable either directly or indirectly into motion, so also are they convertible into one another.

In other words, they are all believed to be the result of *molecular motion, i. e.*, of the motion vibratory, undulatory, or rotatory on or around their axes, of the particles of matter. A molecule is the term used to denote the smallest quantity of any substance, either simple or compound, which can exist in a free state: thus a molecule of common salt is composed of one atom of sodium united to one of chlorine; that of alcohol, of two atoms of carbon, six of hydrogen, with one of oxygen: these are very simple forms, some are much more complex. Matter may be still further divisible; those bodies which we look upon as elements may not be really such: it is believed the medium filling space by which light, heat, etc., are conveyed, is matter in a more elementary condition.

Let us examine the grounds on which the assumptions are based that have caused these changes in our theories.

It is well known that there are vacant spaces between the particles of all matter. Almost all bodies expand when heated, and contract when cooled, that is when heat is taken from them; this is now supposed to be owing to the greater molecular motion of the particles of the bodies when heated. Most substances exist in three different states, solid, liquid, and gaseous; and it is believed that all bodies would do so, if we could only cool or heat them sufficiently, excepting, of course, those compounds that decompose before reaching the requisite temperature.

In solids the molecular motion is considerably overbalanced by molecular cohesion: in fluids these forces are nearly balanced; in gases, the motion is so great, that the particles are mutually repellant within certain limits.

That heat and motion are nearly related is clear enough, for we cannot have one without the other. In bodies expanding with heat we have motion; and in the act of stopping a moving body heat is generated by friction or concussion.

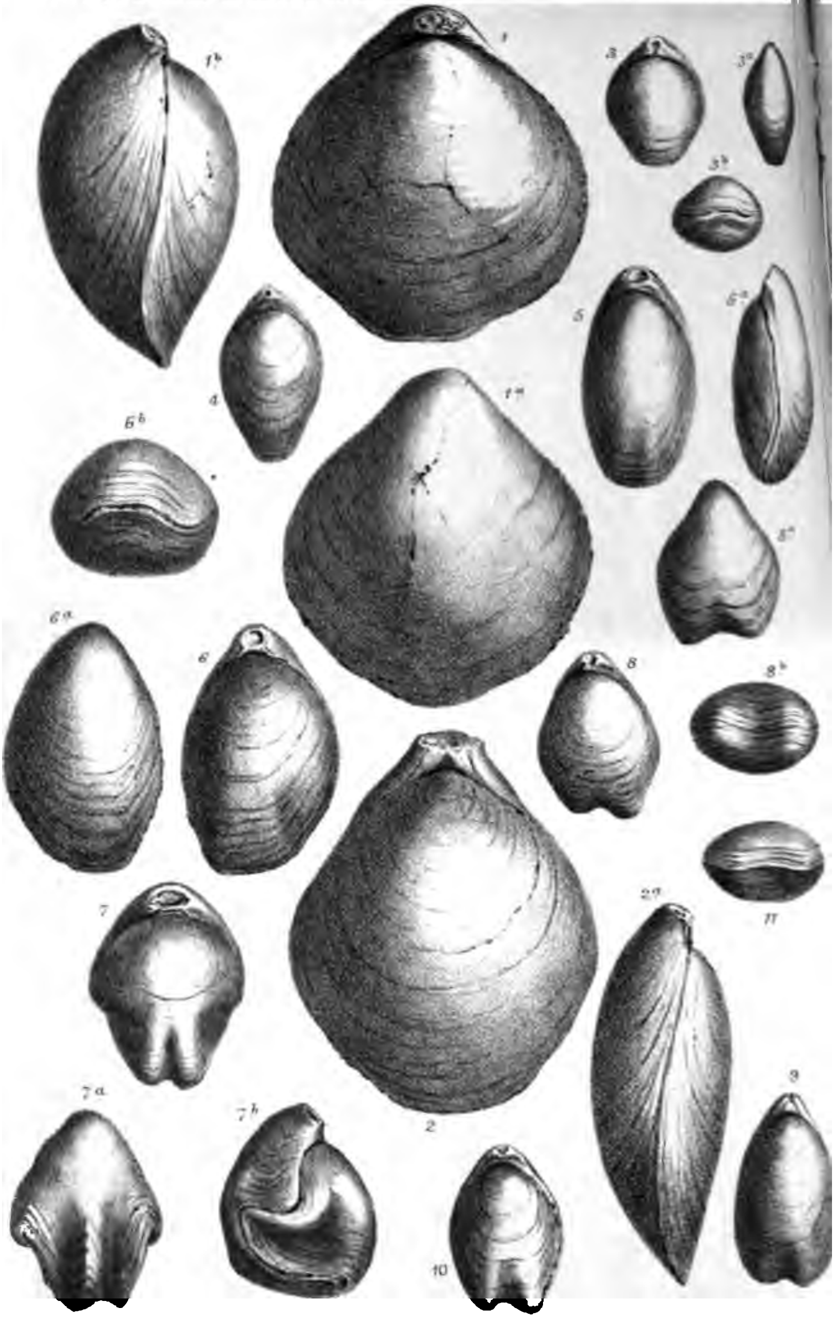
It is one of the great axioms of modern physics that force cannot be annihilated any more than matter. One variety of force may be changed into another variety of force, but the absolute intensity remains exactly equivalent. Thus if a body be allowed to fall, the heat and other forces produced by the concussion would be just sufficient to raise the body to exactly the same height from which it fell, if the forces could be completely collected and economised.

That heat will produce electricity is shown in the thermo-electric pile, our most delicate measurer of heat. This instrument also shows that electricity will produce motion by the repulsion of its index, a freely suspended magnetic needle. Electricity was first noticed as a force that was induced by motion—by the friction of amber—through its power of again inducing motion in alternately attracting and repelling small fragments of light substances: the force expended, being partly converted into heat and partly into electricity.

When electricity is excited in any substance it is found that another mode of force is always simultaneously called into play, viz., magnetism, in a plane at right angles to the direction of the electrical current. By this, magnetism shows that particles have fixed and definite attitudes with regard to one another.

If a magnet be moved across a body capable of conducting electricity transversely to the direction of the lines of magnetic force, an electrical current is developed in that body, or if the magnet be stationary and the conducting body moved in the same relative position to the magnet, the same result is observed. Magnetism seems, in fact, to be purely static; it directs other forces, but does not initiate them, unless motion be superadded. Through the medium of electricity it can produce heat, light, and chemical affinity. Magnetism has a most remarkable influence on light, for it causes the plane of polarization to rotate while passing through water and several other fluid media, which do not in this way alter the direction of the ray under ordinary circumstances.

We might adduce many more instances of this relation and interdependence of the physical forces, showing their convertibility, though this is not in all cases equally apparent: it is easy enough to obtain light by means of heat, but the converse can only be effected indirectly; light will induce chemical action, for instance, in a mixture of hydrogen and chlorine gases, and hence, indirectly, heat. Yet so closely are they connected that it is impossible to excite, produce, or disturb one force without calling others into action. For instance, if sulphide of antimony be electrified, magnetism is induced at right angles to the electrical current, and it becomes heated and therefore expands, producing motion, and if the electrical force be strong enough it becomes luminous and



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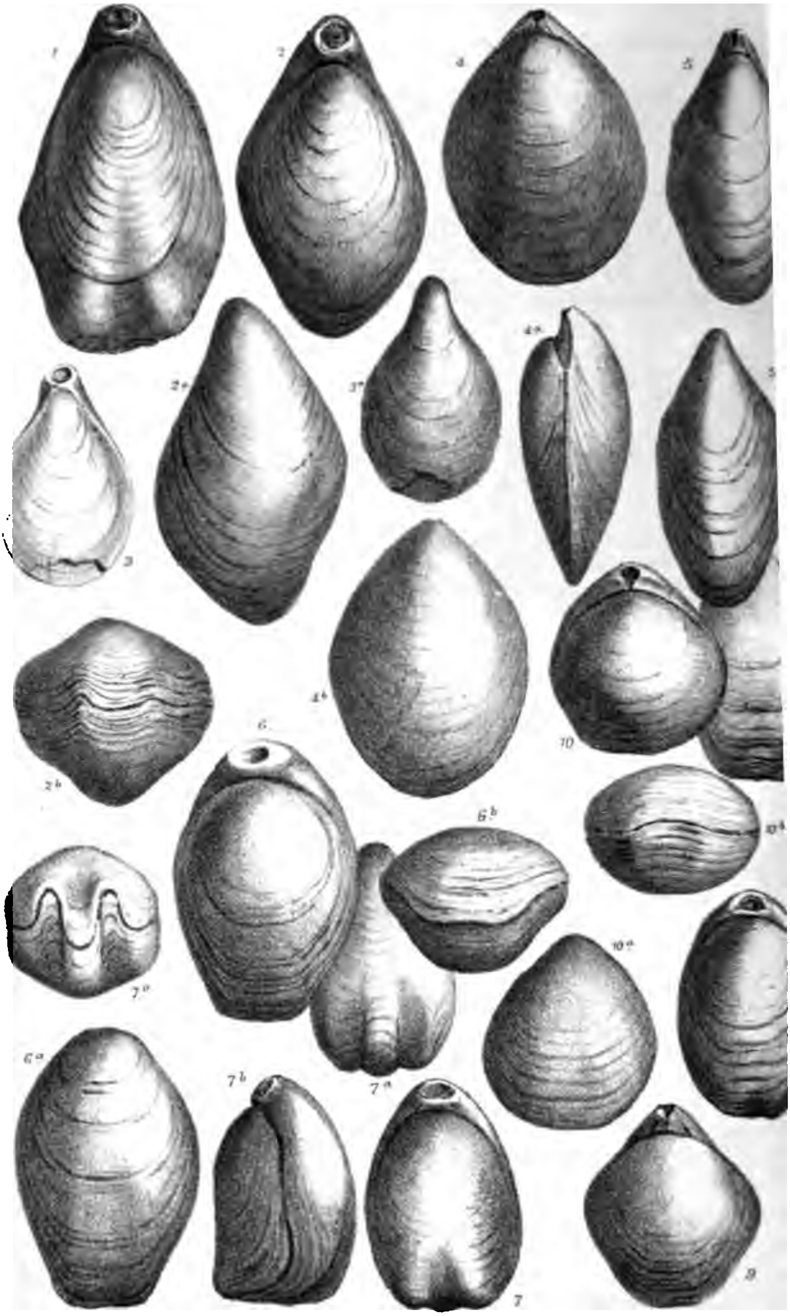
New Species of Brachiopoda from the Lower Green-sand, at Upware.



De Wilde del. et lith W.W.

New Species of Brachiopoda from the Lower Green-sand, at Upware begins to decompose, giving out light and overcoming chemical affinity.

We have endeavoured to show in these few notes how intimately the physical forces are connected, if they be not indeed all modifications of one force.

If the proper comprehension of the phenomena of nature involves a knowledge of physics and chemistry, how necessary must the study of these sciences be to every geological student who diligently seeks to understand the "Testimony of the Rocks."

Every effect produced, however vast, or however limited in extent, is but the exhibition of the direct action of some physical force, inducing also in very many cases chemical change.

The sun's heat converting water into vapour; the winds conveying the rain-cloud from one region to another; the tides and currents of the ocean; the degrading and transporting action of ice and snow, rain and rivers, upon land-surfaces; the re-elevation of the ocean-bed by subterranean force; the deposition from solution or otherwise, of mineral matter in a crystalline form in lodes and veins; the segregation of mineral-matter (originally diffused through strata) into layers, nodules and concretions; the phenomena of volcanoes and thermal springs; these and ten thousand like illustrations might be offered of the effects of physical force (with or without chemical action), operating around us continually.

III.—On the Species of Brachiopoda, which occur in the Lower Greensand at Upware.

By J. F. Walker, B.A., F.G.S., etc.

(PLATES XVIII. and XIX.)

I HAVE in previous papers given some account of the remarkable Lower Greensand deposit at Upware,[1] and have also described three new species of *Terebratulidæ*[2] from this locality. Having obtained additional specimens of the rarer forms, and several new species, and having received many valuable suggestions from Mr. Davidson and Mr. Meyer, I propose in the present paper, first to describe some of the new species, then to make a few remarks on the numerous species of *Brachiopoda* which occur in this deposit, and finally to indicate their distribution in the Lower Greensand deposits of this country.

In the field which is at present worked at Upware, there are found very few of the remarkable sponges, such as *Verticillites anastomosans*, *Manon macropora*, etc., which occurred so abundantly in the field which was being worked when I first gave a short account of the bed. The section in May, 1868, was as follows:—

Sand	4½ft.
Coprolitic bed	3½ft.
Clay	not pierced.

[1] Vide Geol. Mag., 1867, Vol. IV., p. 309, etc.

[2] Vide Geol. Mag., 1867, Vol. IV., p. 454, Pl. XIX.

The coprolite bed becomes more indurated towards the bottom: the last two or three inches, being very difficult to pierce, are generally left. The coprolites towards the bottom of the bed are larger in size. The coprolite bed only extends partly across the field, the Coralline Oolite abruptly terminating the trenches which are dug in working the deposit.[1]

I regard the following as new species:—

Waldheimia mutabilis, sp. n. Pl. XIX. Figs. 4 and 5.—The specimens to which I refer under this specific name, present two strongly marked varieties or sub-species: indeed the differences between these forms are so striking, that I was at first inclined to regard them as constituting two species, until the discovery of intermediate forms convinced me that notwithstanding the remarkable discrepancy in their aspect, they were to be regarded as one: I have, however, considered it desirable to give names to the two forms.

W. mutabilis.—Shell-surface smooth, very slightly marked by faint lines of growth. Beak short, nearly straight, truncated by a small triangular foramen: beak ridges moderately well defined, space between the ridges and hinge-line nearly flat: deltidium large, in two pieces; loop long, front margin not plicated or waved.

Var. or sub-sp. *W. elliptica.* Pl. XIX. Fig. 4. *4a-4b.* Shell ovate, its edges sharp, both valves are nearly flat but slightly convex towards the beak. Dimensions: length, 1·375 inches; breadth, 1·125 inches; thickness, ·625 inches.

Var. or sub-sp. *W. angusta.* Pl. XIX. Fig. 5-*5a.* Shell very much elongated, very narrow compared with its length, both valves moderately convex. Dimensions: length, 1·42 inches; breadth, ·75 inches; thickness, ·42 inches. The var. *W. elliptica* approaches nearest to some forms of *T. depressa*, from which it can be readily distinguished by the loop, by the smaller size and triangular form of the foramen, and by the deltidium being in two pieces. The var. *W. angusta* is well distinguished from *W. celtica* by its nearly straight beak, and by being narrower, etc. From *T. extensa* by its loop, etc.

Waldheimia rhomboidea, sp. n. Pl. XVIII. Figs. 3, *3a.*, *3b.* and 4. —Shell elongate, widest near the middle of the shell, thence gradually narrowing towards both extremities, so as to acquire a somewhat rhomboidal form. Beak incurved, truncated by a moderate-sized foramen. Beak ridges sharp, space between the ridges and hinge-line concave; deltidium in two pieces. Shell surface smooth, marked by faint concentric lines of growth. Both valves regularly convex, frontal margin not plicated, loop long. Dimensions: length ·94 inches to ·625 inches; breadth ·625 inches to ·5 inches; thickness, ·5 inches to ·375 inches. This species approaches nearest to *W. Morrisii Meyer* and *W. tamarindus*, Sow. It may be distinguished from *W. Morrisii* by its peculiar elongated form tapering from the middle of the shell to the front margin, by its valves (especially the dorsal) being more convex, and by the sides of the shell being more rounded. From *W. tamarindus* it differs by its more elongated form, and Mr. Meyer informs me that its loop resembles that of *W. Morrisii.*

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[1] See notice by Mr. Henry Keeping (the intelligent assistant to Prof. Sedgwick in the Woodwardian Museum) in the GEOLOGICAL MAGAZINE for June last (p. 272) of the succession of beds in the Upware deposit, accompanied by a woodcut.

Terebratula Meyeri, sp. n. Pl. XIX. Fig. 6.—Shell somewhat ovate, inflated, greatest thickness near the middle of the shell. Shell-surface smooth, strongly marked by concentric lines of growth, beak short, incurved and depressed, truncated by a large foramen, whose transverse diameter is generally the greater. The foramen is separated from the hinge line by a wide but shallow deltidium in one piece; beak ridges inconspicuous. Ventral valve increasing regularly in convexity from its sides to its centre. Dorsal valve increasing in convexity both from its sides and also from the beak and front margin nearly to the central point of the shell. Both valves slightly taper towards the front margin; which, in some specimens, is almost straight, giving the shell a slightly pentagonal form. This last character is more marked in some specimens than in others; the front margin is slightly flexuous and not plicated; loop short. Dimensions: length, 1·42 inches; breadth, ·96 inches; thickness, ·83 inches. This shell is readily distinguished by its shape from other Cretaceous *Terebratulæ.* I have dedicated this species in compliment to C. J. A. Meyer, Esq., who has added much to our knowledge of Cretaceous Brachiopoda.

Terebratula microtrema, sp. n., Pl. XIX. Figs. 7 and 8.—Shell somewhat ovate, widest towards the frontal margin, much compressed at the sides. Beak ridges rounded, beak short, truncated by a large foramen; separated from the hinge line by a wide but very shallow deltidium in one piece; ventral valve slightly convex towards the beak, becoming flattened towards the front margin, much compressed at the sides; dorsal valve slightly convex near the beak, sides somewhat flattened. Frontal margin more or less plicated, the ventral valve having an elevation on each side of the centre, interlocking with the ventral depression or furrow of the dorsal valve. These elevations and depressions are sometimes nearly wanting, so that the frontal margin is only a little undulated. In most adult specimens the plications become greatly developed, deeply interlocking; and the front of the ventral valve shows a strong central ridge with a shallow furrow on each side of it. Loop short. Shell structure very peculiar, having but very few and small perforations. (Woodcut, Fig. 3.) Dimensions; length, 1·17 inches; width, ·83; thickness varies from ·625 to ·75 inches.

The plicated specimens approach nearest to *T. prælonga;* from which, however, the species may be at once distinguished by its peculiar shell-structure. It is also more compressed at the sides, the foramen is more approximated to the hinge line, and the beak is shorter. It is well distinguished from *T. biplicata* by its shell structure and general shape. The forms in which the plications are less conspicuous approach most nearly in appearance to *T. extensa,* but they differ from that species in shell structure, in being wider, and in the ventral valve being flattened towards the front margin. I originally placed some of the specimens on which I found this species among the varieties of *T. prelonga* and others among those of *T. extensa*. Mr. A. Wanklyn having kindly made for me some microscopic preparations of the shells of *Terebratulidæ* from the deposit at Upware, we found that these doubtful specimens presented a peculiar and accordant structure. quite distinct from that of both *T. extensa*

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

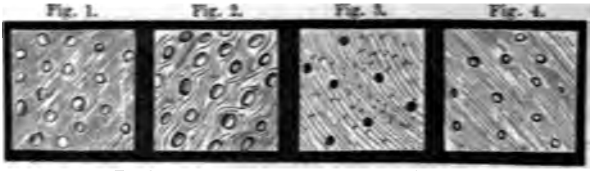

Fig. 1. *Terebratula prælonga*, Sowby. magnified 75 times.
" 2. " *extensa*, Meyer, " "
" 3. " *microtrema*, sp. nov. " "
" 4. " *Lankesteri*, " " "

and *T. prælonga*. In all the specimens of all forms of this species which we have examined, the shell has very small and widely separated perforations. as shown and contrasted with the structure of *T. extensa* and *T. prælonga* in Woodcut, Fig. 3.

Terebratula Lankesteri, sp. n. Pl. XIX. Fig. 2.—Shell ovate, elongate, tapering towards the beak, rounded towards the front margin. Dorsal valve moderately convex, widest near its middle. Ventral valve very much arched, widest near the middle, bent almost at a right angle near the front margin, and tapering considerably towards the beak; beak very much incurved, truncated by a large foramen; deltidium moderately wide but very shallow, in one piece; beak-ridges ill defined; front margin of the valves flexuous. Shell-surface marked by fine longitudinal striæ on both valves, and with concentric lines of growth; loop probably short. Shell structure,—the perforations are smaller and wider apart than in *T. prælonga*. This species may be distinguished from *T. prælonga*, by its surface being covered with fine striæ, by its more oval shape, the absence of plications at the front margin, the tendency of the front margin to become inflated, by its shell structure, by its beak being more incurved, and by the deltidium being shallower. From *T. Dallasii* it differs by being longer and more oval, and by its striated surface. From *T. capillata*, by being more elongated, by its ventral valve being more tapering towards the beak, by the dorsal valve being less convex, and by its beak being longer. The specimen here figured was obtained by Mr. N. Moore, of St. Catherine's College, Cambridge, who kindly gave it to me. Dimensions: length, 1.625 inches; breadth, 1 inch; thickness, 1.04 inches.

A small specimen figured, Pl. XIX. Fig. 3, is probably a young example of *T. Lankesteri*. It exhibits the same general outline of the ventral valve, and the surface is covered in the same way with fine longitudinal striæ. Dimensions: length, 1·1 inches; breadth, ·75 inches; greatest thickness, ·375 inches. I have much pleasure in naming this species after E. Ray Lankester, Esq., B.A.

I add the following notes on the other species of *Brachiopoda*, which have been found in this deposit.

Terebratula prælonga, Sow. (Geol. Trans., 2nd series, vol. iv., pl. xiv., fig. 14).—Pl. XIX., Fig. 1. This species was found not uncommonly in 1867, but appears to be rare in the field that is at present worked. The largest specimen that I have obtained of this species measures: length, 2·08 inches; breadth, 1.08 inches; thickness, 1·125 inches.

T. Dutempleana, d'Orb.—I have obtained some specimens which appear to belong to this species.

T. Moutoniana, d'Orb. Pl. XVIII., Fig. 6.—This species appears to be the true *T. Moutoniana*, d'Orb. Mr. E. R. Lankester, in the Geologist, vol. vi., p. 414, stated that he had identified a fossil from the Lower Greensand of the Isle of Wight as belonging to this species, which has since been described by Mr Meyer as *Waldheimia Morrisii*, in the GEOLOGICAL MAGAZINE for June (p. 268). The true *T. Moutoniana* of d'Orb. being a *Terebratula*.

The following is a translation of d'Orbigny's description of this species, with which my specimens agree:—"Shell oval, depressed, elongated, narrowed, and obtuse in the cardinal region, widened and truncated in the pallial region, entirely smooth, or with radiating striæ; superior valve (ventral valve) larger and more convex than the other, much arched, with the apex strongly recurved and truncated, the sides not keeled; its pallial region is slightly prominent as if truncated. Inferior (dorsal) valve convex in the middle, depressed at the sides. Foramen large, furnished with a very short deltidium. Lateral commissure of the valves much arched, recurved towards the base at its extremity. Pallial commissure very sinuous to the middle, which is nearly straight, then elevated laterally to be again depressed." This species, according to d'Orbigny, is most nearly allied to *T. sella*, from which it differs in the want of the double folds at its pallial extremity. It differs from *T. extensa* in its greater convexity, and the depression of the sides of its dorsal valve, and by its width being greater in proportion to its length. From *T. Meyeri*, it may be distinguished by its dorsal valve being depressed at the sides, and more unequally convex, by its beak being longer and not so broadly truncated. It is easily distinguished by its short loop from *W. Morrisii*, which is also a flatter shell. I have observed on some few specimens traces of the striæ which d'Orbigny states occasionally occur. Deformed specimens are sometimes met with. Dimensions: length, 1·3 inches; breadth, ·875 inches; thickness, ·75 inches.

Terebratula sella, Sow. Pl. XVIII. Fig. 7.—This shell abounds at Upware, where several varieties are met with. I have figured one of these, which occurs in great numbers in this deposit. No specimens of this shell have yet been found in the Potton conglomerate.

Terebratula depressa, Lamk.—The specimen here figured, Pl. XVIII. Fig. 2, agrees in all respects with those obtained from Tournay. This species attains to a very large size at Upware. I possess a specimen which measures in length 2·8 inches; breadth, 2·5 inches;

thickness, 1·1 inches; but in the Woodwardian Museum, Cambridge, there is a larger specimen, which was obtained by Mr. Henry Keeping, who kindly gave me its dimensions. Length, 3·3 inches; breadth, 2·8 inches; greatest thickness, 1·5 inches. I have separated the convex specimens of this species, which have a short and rounded beak as a variety or sub-species, under the name of *T. depressa* var. *cyrta*, Pl. XVIII. Fig. 1. Shell convex, inflated, width and length nearly equal, becoming flatter towards the frontal margin; beak short, rounded, truncated by a large foramen. Beak ridges ill-defined; deltidium in one piece, wide, but shallow. Ventral valve globose; dorsal valve very globose towards the beak. Frontal margin not plicated, the valves slightly flexuous. Shell surface smooth, slightly marked by concentric lines of growth. Loop short. Dimensions: length, 1·75 inches; breadth, 1·625 inches; thickness. 1·04 inches.

This variety occurs at Upware and at Potton along with the typical form, from which it differs by its greater convexity, by its beak being shorter and more rounded, and by its deltidium being much shallower.

T. Dallasii, nobis, (GEOL. MAG. Vol. IV. p. 455, Pl. XIX. Fig. 1.).—Since I described this species, I have obtained specimens of larger dimensions. Length, 1·33 inches; breadth, 1·12 inches; thickness, ·92 inches. A single ventral valve measures: length, 1·5 inches; breadth, 1·25 inches.

This species differs from globose specimens of *W. tamarindus*, with which it has been compared, in having its deltidium in one piece, its beak ridges ill-defined and rounded, and the space between them and the hinge line not concave; the foramen is also larger. A specimen presented by me to the York Museum has been cut open by Mr. Dallas, who found that it has a short loop, somewhat resembling that of *T. depressa*, to which this species is certainly most nearly related.

T. extensa, Meyer. Pl. XVIII. Fig. 5.—This species,—described by Mr. Meyer as occurring at Godalming, in the GEOL. MAG. Vol. I.,—occurs also at Upware, where it attains a large size, agreeing with the Godalming specimens in form and in shell-structure. Some varieties of this species approach somewhat in form to *W. celtica*, but have a short loop. Dimensions: length, 1·16 inches; width, ·66 inch; thickness, ·56 inch.

Waldheimia Woodwardi, nobis. (GEOL. MAG. Vol. IV, Pl. XIX. Fig. 3.)—I have obtained several more specimens of this species; the largest measures: length, 1·58 inches; breadth, ·875 inch; thickness, ·75 inch; the smallest specimen: length, ·75 inch; breadth, ·45 inch; thickness, ·375 inch. The dorsal valve of this specimen is deeply channelled. The peculiar shape of the ventral valve appears to be constant; the deltidium is in two pieces; the dorsal valve is generally much more grooved than in the specimen I figured. Since I described this species I have seen its loop, which extends nearly to the front margin. This species is easily distinguished from specimens of *W. celtica* by the shape of its dorsal valve, etc.

Waldheimia tamarindus, Sow., var. *magna*. Plate XIX., Figs. 9 and 10.—This species varies considerably in form. Some specimens are more globose than others; some assume a somewhat pentagonal shape. Most of the varieties found in the Isle of Wight occur at Upware, but the nature of the latter locality appears to have been favourable to their greater development. Mr. E. R. Lankester and Mr. Meyer having kindly given me numerous specimens of this species from the Isle of Wight, I have been enabled to compare them with the Upware specimens, which to differ only in their larger size. I have figured two forms. Dimensions of figured specimens: length, 1·04 inches and 1·08 inches; width, ·97 inch; thickness, ·69 to ·63 inch. This species is the one which occurs at Potton, in the greatest abundance, where it attains its greatest size.

Waldheimia celtica, Morris.—I am not certain that any true specimens of this species have yet been found at Upware, but I have one or two which somewhat resemble it.

Waldheimia pseudo-jurensis, Leym. Pl. XVIII., Figs. 8, 9, 10, and 11.—The specimens which I have referred to *W. pseudo-jurensis*, have recently been found at Upware, in considerable abundance. This species varies in thickness, shape of the front margin, etc. The specimens appear to agree closely with Leymerie's figures. Mr. Meyer informs me that he has found specimens of a shell somewhat resembling this at Godalming, but he had referred it to *T. Boubei*, d'Arch. I have figured two or three varieties. Dimensions: length, ·875 inch to 1 inch; breadth, ·625 inch to ·66 inch; thickness, ·44 inch to ·5 inch.

Waldheimia? Davidsoni, nobis. (GEOL. MAG. Vol. IV., p. 454, Pl. XIX., Fig. 4.)—Mr. Meyer informs me that he has found specimens of this species at Godalming, in Surrey. He has succeeded in obtaining a good view of the loop, and says that it is doubly attached, "but differs slightly from the ordinary form of *Terebratella*, in that the extremity of the reflected portion of the loop almost touches the septum." The species will, therefore, probably, have to be named *Terebratella Davidsoni.*

Terebratella Fittoni, Meyer.—This shell is extremely abundant at Upware. It varies in form, in the degree of convexity of the dorsal valve, in the beak being more or less recurved, and in the fineness and closeness of its ribs. The Godalming specimens appear to be generally more coarsely ribbed than those from Upware.

Rhynchonella.—Of this genus, I have identified the following species:—*R. Gibbsiana*, Sow.; *R. parvirostris*, Sow.; *R. depressa*, Sow.; *R. antidichotoma*, Buv.; *R. lata*, d'Orb.

I have arranged them in the inverse order of their rarity. At Potton *R. antidichotoma* and, I think, *R. depressa* and *R. lata* occur.

Besides these species which I have determined, there are some doubtful forms. This bed is indeed very remarkable for the number of species, and also for the abundance of individual specimens found in it; the latter circumstance is associated with very considerable amount of variation, and the specimens generally attain a large size. This is due, no doubt, to the nature of the deposit, as a large supply of calcareous matter would be furnished by the proximity of the Coral Rag. The late Dr. Woodward, in his "Manual of the Mollusca" remarks that "where the bottom consists of calcareous mud the Brachiopoda appear to be very abundant, mooring themselves to every hard substance on the sea-bed and clustering one upon the other." page 213.

Another peculiarity of the beds is to be found in the distribution of these small fossil species having occurred in almost every field where the bed has been worked. I have no doubt that several more species will be added to this list, but in the meanwhile, I give a Table of the species which have been found in the Lower Greensand of England, including the Farringdon deposits.

LOWER CRETACEOUS BRACHIOPODA.	UPWARE.	POTTON.	GODALMING.[1]	FARRINGDON.	ISLE OF WIGHT.	KENT.
Lingula truncata, Sowerby					●	●
Crania cenomanensis, d'Orbigny				●		
Thecidea Wetherellii, Morris				●		
Terebratella oblonga, Sow.			?	●	●	●
——— *Fittoni*, Meyer	●		●			
——— *Menardi*, Lamarck			●	●		
——— *trifida*, Meyer			●			
Terebratella? Davidsoni, Walker	●		●			
Waldheimia mutabilis, sp. n.	●					
——— *pseudo-jurensis*, Leymerie	●		?			
——— *tamarindus*, Sow.	●	●	●	●	●	●
——— *Morrisii*, Meyer			●		●	
——— *rhomboidea*, sp. n.	●					
——— *celtica*, Morr.	?				●	
——— *Woodwardi*, Walk.	●					
Terebratulina striata, Wahlenberg			●			
Terebratula prælonga, Sow.	●					●
——— *Dutempleana*, d'Orb.	●	?		●		
——— *Lankesteri*, sp n.	●					
——— *microtrema*, sp. n.	●		?			
——— *extensa*, Meyer	●		●			
——— *Robertoni*, d'Archiac			?	●		
——— *tornacensis*, d'Arch.	?		●	●		
——— *sella*, Sow	●				●	●
——— *Moutoniana*, d'Orb.	●					
——— *Meyeri*, sp n.	●					
——— *depressa*, Lamarck	●	●	●	●	[2] ●	
——— var. *cyrta*	●	●				
——— *Dallasii*, Walk.	●	●				
Rhynchonella Gibbsiana, Sow.	●		●		●	●
——— *parvirostris*, Sow.	●				●	
——— *depressa*, Sow.	●	?	?	●	●	
——— *antidichotoma*, Buvignier	●	●		●		
——— *lata*, d'Orb.	●	?	●	●		
——— *nuciformis*, Sow.				●		

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[1] I am indebted to the kindness of Mr. Meyer for a list of the species found at Godalming, and also for specimens from that deposit.

[2] This species was discovered by Mr. E. R. Lankester in the Lower Greensand of Isle of Wight.

DESCRIPTION OF PLATES XVIII. & XIX.

PLATE XVIII.

Fig. 1–1*b*. *Terebratula depressa*, var. *cyrta*.
2–2*a*. *T. depressa*, Lamk. typical form.
3–3*b*. *W. rhomboidea*, sp. n.
4. *W. rhomboidea*, large specimen.
5–5*a*. *T. extensa*, Meyer.
6–6*b*. *T. Moutoniana*, d'Orb.
7–7*b*. *T. sella*, Sow.
8–8*b*. *W. pseudo-jurensis*, Leym.
9, 10, 11. *W. pseudo-jurensis*, Leym. To show different forms.

PLATE XIX.

Fig. 1. *T. prælonga*, Sow.
2–2*b*. *T. Lankesteri*, sp. n.
3–3*a*. *T. Lankesteri*, sp. n. jun.
4–4*b*. *W. mutabilis*, sp. n. var. *elliptica*.
5–5*a*. *W. mutabilis*, sp. n. var. *angusta*.
6–6*b*. *T. Meyeri*, sp. n.
7–7*c*. *T. microtrema*, sp. n.
8–8*a*. *T. microtrema*, sp. n.
9. *T. tamarindus*, Sow. var. *magna*.
10–10*b*. *W. tamarindus*, Sow. var. *magna*.

I have presented to the British Museum the specimens figured in illustration of this and my former paper.—J. F. W.

IV.—ON ROSLYN OR ROSWELL HILL CLAY-PIT, NEAR ELY.[1]

By the Rev. O. FISHER, M.A., F.G.S.

ROSLYN or Roswell Hill Clay-pit has long been a standing puzzle to Cambridge geologists. I have visited it several times, and have notes upon it made in 1853 and in 1856. I was there in November, 1866, having, by Professor Sedgwick's permission, the the assistance of Mr. H. Keeping.

The pit is probably well known to you. It covers several acres of ground, and extends in a direction N.W. and S.E. The material has been used for the purpose of making up the banks in the fens, and the section is comparable to that of many natural cliffs.

The northern side of the pit is occupied by horizontal Kimmeridge clay, which is, or used to be, capped here and there by a thin covering of Lower Green-sand. At the western end of the pit Boulder-clay of a typical character abuts against the Kimmeridge clay, the plane of junction running nearly east and west, and dipping at a high angle under the Boulder-clay. The southern side of the pit, as at present exhibited, shows a blueish grey Cretaceous clay, flanked at either end by nearly vertical Chalk-marl, which becomes somewhat argillaceous towards the eastern end of the pit. The Chalk-marl and clay are evidently in true sequence.

The question which I propose to discuss relates to the singular collocation of these several beds.

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[1] Read before the Cambridge Philosophical Society. As this paper was somewhat severely criticised by Mr. Seeley in our last No. (p. 347), we gladly avail ourselves of the author's permission to reprint it here.—EDIT.

I will first of all consider the presence of the Chalk-marl and the clay on the northern side of the pit.

I have said they are clearly in sequence. Their junction is perfectly natural. The Chalk-marl becomes sandy, and contains a few scattered nodules of phosphate of lime, with some of the fossils of the Upper Green-sand usual in the neighbourhood of Cambridge, and then the clay succeeds. The character of the beds here has been so well described by Mr. Seeley,[1] that I need not say more about them, except that I think it open to question whether the clay is really Gault. There is about Cambridge a band of clay in the lower part of the Chalk. which was well shown in the construction of the waterworks at Cherryhinton, and I am rather inclined to think that the Ely clay belongs to the same bed. I recollect phosphatic nodules occurring in connection with it at Cherryhinton. I think the abundance of shells, and especially of *Perna*, in the Ely clay, rather militates against its being Gault, but I merely throw this out as a suggestion.[2]

BORING BY MR. DOCWRA AT CHERRYHINTON WATERWORKS NOTED IN 1854.

	ft.	in.		ft.	in.
"Soil	1	0	Clunch	6	0
Plastic	29	0	Sand...	0	8
Upper Green-sand with fossils	0	10	Gault not pierced	45	0
				82	6"

I visited the spot and found *Belemnites* in the "Plastic," and coprolites from the supposed Upper Greensand. From a subsequent cutting made to convey water from near Mr. Okes's house, I recollect observing that the above-mentioned "plastic" was a stratum in the clunch. This section makes a coprolite layer beneath the clay. There may also be one above it.

At any rate we may look at the Chalk and clay near Ely as a single mass, and whatever accounts for the presence of one will equally account for the other. In short they are a large mass of Cretaceous beds in a nearly vertical position, with Boulder-clay abutting upon them. The curved lines of junction as seen in the section are nothing more than the curves formed by the intersection of the surface of the workings with a nearly plane surface of junction between the Chalk and the Gault, dipping at a very high angle towards the north.

Now there are two ways of accounting for the presence of this Cretaceous mass. It is either brought *up* by a fault with reference to the Boulder-clay, but *down* with reference to the Kimmeridge, or else it is a huge boulder, forming as much an integral part of the Boulder-clay as any block of Oolite or flint which it contains.

Mr. Seeley appears to consider its presence best accounted for by a fault, but I think I shall be able to show that the other is the more probable explanation.

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[1] GEOL. MAG., Vol. II., p. 529.

[2] At a subsequent visit, 26 April, 1867, I saw the Lower Green-sand in sequence to this clay, which would make it the true Gault. In another part of the pit the Gault reposed on Boulder-clay with Chalk pebbles.

And to clear away any possible *a priori* objection drawn from the magnitude of the mass, I would beg to remind you that Chalk boulders occur in the Norfolk drift so large that quarries and lime-kilns are worked in them.

The following is an extract from a letter by the Rev. John Gunn:—

IRSTEAD, *Dec.* 10, 1866.

"Of the masses of Chalk you enquire about, that near Castle Rising is now exhausted and used for top-dressing land. Only the large flints remain to prove that the mass belonged to the Upper Chalk which does not remain anywhere in that part of West Norfolk.

"The largest detached mass I know of is between Cromer and Overstrand. I do not know the precise boundary of the parishes. It has been for years used for lime and a kiln is on the premises. Mr. Prestwich as well as myself noticed a layer of sand beneath it. (*Obs.* They evidently looked for proof that the mass was not *in situ,* showing how nearly it simulated a natural bed of Chalk.) In several places north of Cromer, from that place to Sherringham, are large masses of bouldered Chalk, proved to be so by the underlying beds. On the south side also, at Barton and Happisburgh, there were some, but they have been all washed away. In North Walsham, Worstead, and Witton, large bouldered masses have from time to time been worked, either for making lime or for top-dressing. A tooth of *Elephas primigenius* was obtained by me at Witton in connection with one. The large masses at Trimmingham, figured in Lyell's Elements, are part of the fundamental Chalk, remnants of an upper bed, from which the gravel of East Norfolk is derived."

These instances show that the mere size of the mass of Cretaceous strata at Ely is no argument against its having been carried thither by ice, and the fact of its consisting of portions of two distinct beds is a mere accident.

There is nothing singular in so large a block of Chalk becoming detached from its parent bed. For some miles along the coast, west of Lyme Regis, landslips on a large scale have occurred, where masses of Chalk and Green-sand, fully equalling in bulk the mass at Ely, have fallen from the cliff. The last of these falls occurred not many years ago. The lower portion of the disengaged strata consisted of a sandy loam, the upper of Chalk.

If we could conceive such circumstances under a glacial climate that this mass could have been floated away, as for instance by snow blowing over the top of the cliff and being frozen on to its face, we should have all the conditions necessary for the deposition of an immense boulder like that at Ely; and on this supposition we might expect it to have been dropped in a similar position of verticality, for the float would have been attached to its edge. But without making such a supposition, knowing how frequently icebergs roll over in the process of thawing, we may expect them to drop their loads indifferently in all positions.

I was originally disposed to think this mass a boulder, when I saw it ten years ago. It was then much less exposed than it is at present. I was quite confirmed in that opinion by what I saw the other day.[1]

The mass seems to be much of the shape of a great punt, the prow of which is directed towards the west. The mass is so thick towards the stern, *i. e.* at the eastern end, that they have not dug through it, but towards the centre the workmen told me they found a "snuff-coloured hard clay," at the bottom of the pit beneath the Chalk. "hard clay" being the term by which they designate the Boulder-clay. Towards the western end of the exposure of the Chalk this clay may be seen beneath it in the section, enclosing angular lumps of chalk. Towards the cottage on the bank the Chalk thins out to nothing. the Boulder-clay passing beneath it.

I believe the Lower Green-sand blocks which occur on the south side hereabouts to be no more *in situ* than the Chalk.

The Boulder-clay between the Chalk and Kimmeridge clay shows tortuous streaks of bedding, (some of them chalky,) in a highly inclined position. They seem to have been originally horizontal as well as the Chalk. But no one who has seen the Cromer cliffs will think any mode of bedding too strange to occur in the Boulder-clay, or call in the aid of a fault to account for it.

The second part of the enquiry relates to the occurrence of this mass of Boulder-clay in juxtaposition to the Kimmeridge-clay. The question lies between a fault and a great channel of erosion, made for itself by the Glacial drift.

The only evidence upon this point to be obtained *in the pit* is by examining the junction. If the country were mapped, and a fault affecting other strata traced through the pit, this would settle the question in favour of a fault. There seem to be disturbances in the neighbourhood. We have Oxford clay, for instance,[2] at the bottom of the hill near the railway station, where Kimmeridge-clay would have been more natural. And other places might be named (Aldreth and Alderforth). But that faults affect the Oolite affords only a slight presumption that they will also affect the Boulder-clay. With regard to the evidence to be obtained at the spot itself, I first of all attempted to examine the junction by digging in the side of the pit; but I found that, owing to a line of springs thrown out by it, the Boulder-clay has slipped, so that I could not reach the undisturbed ground. This circumstance misled me when I examined the place in 1856, and made me suppose the junction showed slikenside, which was really due only to a recent slip. I then searched for, and found the junction in one of the banks left by the workmen to exclude the water as they dig.

Here I found it well defined; but I could not discover any of those symptoms of pressure, or the polished surfaces, which are always observed to accompany a fault. As far then as the evidence goes it is against the occurrence of a fault, and points to the Boulder-clay occupying a trough, which it has ploughed out for itself in the old sea-bottom of Kimmeridge-clay. Such troughs I believe to be not uncommon in districts bordering upon extensive spreads of the Boulder-clay.

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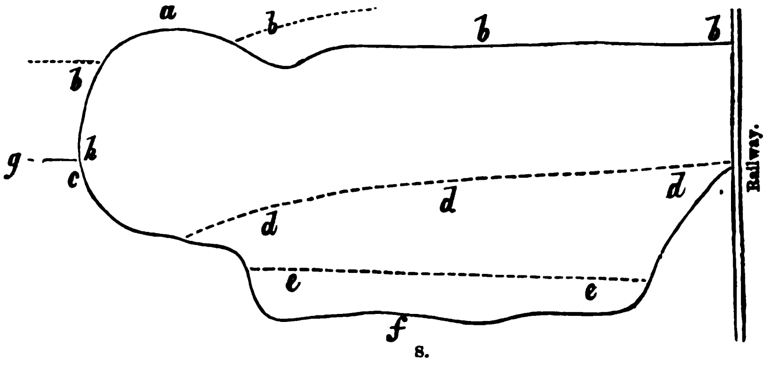
[1] See also Note 2, p. 52.

[2] I have since learned, however, that a well at Ely commenced in the Kimmeridge soon reached the Oxford clay with a thin stony band containing *Nerinæa* intervening.

I have made notes of sections seen in two Boulder-clay pits at Gillingham in Norfolk, and at Bulchamp in Suffolk, which illustrate the manner in which the sea-bottom has been eroded by icebergs, and the cavities filled with Boulder-clay. In the instance at Bulchamp, which I saw with Professor Liveing last summer, the sea-bottom has consisted of sand, of an age some degree anterior to the Boulder-clay. This case has been, like that at Ely, adduced as an instance of faulting; but we noticed sand of the same character as that at the side of the section, clearly continued beneath the clay.

In the other case the Boulder-clay has been originally deposited upon the same sand, but has been subsequently itself eroded down to its very base, and the channel filled again by a fresh deposit of slightly different materials.



Ground Plan of the Ely Clay-pit. The width from N. to S. is exaggerated.

(*a*) Lower Green-sand.
(*b*) Kimmeridge clay.
(*c*) Erratic clay, with boulders of granite, Oolite, large flints, etc.
(*d*) Chalk.
(*e*) Gault (?)
(*f*) Lower Green-sand.
(*gh*) Line of junction.

V.—NOTE ON THE GRAVEL BEDS OF FINCHLEY.

By Professor MORRIS, F.G.S.

THE gravel beds of Finchley, which belong to the Drift or Boulder-clay series, have yielded to the researches of Mr. N. T. Wetherell, of Highgate, many specimens of Flints, containing fossils of the Chalk formation,—of these, the genera *Inoceramus* and *Pecten* are most abundant, associated with which are casts of *Ammonites*, and specimens of *Terebratula*, *Rhynchonella*, *Dianchora*, *Lima Hoperi*, *Spondylus spinosus*, and many Echinoderms, as *Micraster*, *Cardiaster*, (similar to one from Northfleet,) two or three species of *Cidaris*, *Cyphosoma*, *Ananchytes*, *Galerites*, but with these it is important to notice there are sometimes found *silicified* specimens of *Venericardia planicosta*, a condition in which these shells are rarely found in their original Eocene beds. It may be further interesting to notice that

Mr. Wetherell has also obtained, during the excavation of the London clay at the Highgate tunnel for the Edgeware and Highgate railway, a fine specimen of the *Belosepion* (*B. sepioides,* De Blainv.) similar to that figured by Mr. F. E. Edwards in his valuable monograph on the Eocene Mollusca (Palæont. Soc. 1849, Tab. L, fig. 1, b) and found in the London clay of the Isle of Sheppey, and which now forms part of the Dixon collection in the British Museum. Mr. Wetherell's specimen is somewhat elliptical in form, convex, and measures about 3½ inches in length, by 2 inches in breadth, and 1 inch in depth; it is strongly and broadly ribbed, the outer shell preserved in some places, is of moderate thickness, nearly smooth, and faintly marked by lines of growth, which are crossed by finer lines or striæ, giving the shell a somewhat decussated appearance when carefully examined.

VI.—NOTE ON *AXINOPSIS* GEN. NOV. *v.* *SCHIZODUS* ET *AXINUS.*

By RALPH TATE, F.G.S.

PROFESSOR KING instituted the genus *Schizodus* for the reception of certain species of bivalves occurring in the Permian and Carboniferous systems, which had previously been quoted under the generic title of *Axinus*. In Dr. Woodward's Manual of Mollusca, 2nd edit. p. 431, *Axinus* is retained for these shells; and *Schizodus* is reduced to a synonym, because the name applied by Professor King had previously been employed by Mr. Waterhouse.

The type of Sowerby's genus *Axinus* is *A. angulatus*, and with it are associated other Tertiary species and several existing forms. Now, *Axinus*, as so typified and illustrated by Mr. Gwyn Jeffreys, belongs to the family *Lucinidæ,* whilst the older shells belong to *Trigonidæ;* these latter can no longer be referred to *Axinus*. And to avoid the dual employment of this generic name I would propose that of *Axinopsis* for the species hitherto quoted under *Schizodus,* and incorrectly under *Axinus*.

A very common shell familiarly known as *Schizodus* vel *Axinus cloacinus* was first described by Bornemann as *Tæniodon Ewaldi.* This generic name was adopted from Dunker, who, in 1849, described and figured a Liassic shell *Tæniodon ellipticus* as the *type* and *unique* example of a new genus. But *Tæniodon,* as thus proposed is simply equivalent to *Pleuromya,* and cannot consistently be adopted for the group of shells under consideration.

I do not intend to submit a monograph on the genus, my object is simply to avoid an inconvenience which is certainly experienced in the preparation of lists of fossils; but I may state that *Axinopsis* ranges from the Carboniferous series to the true Lower Lias, is widely distributed throughout Europe, and is known in the Carboniferous and Permian strata in North America.

The synonyms of the genus *Axinopsis* (Tate) would be as follows:

Schizodus, King (non Waterhouse).
Axinus, Auctores (non Sowerby, 1821).

NOTICES OF MEMOIRS.

NOTES ON SOME OF THE FOSSIL MAMMALS OF GREAT BRITAIN.

By the Rev. W. S. SYMONDS, F.G.S.,
President of the Malvern Naturalists' Field-club.

[Being the substance of a discourse delivered at Apperley Court, the residence of Miss Strickland, to the members of the Malvern Naturalists' Field-club, June 30, 1868.][1]

I HAVE on more than one occasion directed the attention of the members of this society to the fossil remains of Mammalia found by the late Mr. Hugh Strickland in old Post-glacial river drifts of an ancient Avon, near the villages of Cropthorne, Bricklehampton, and Fladbury, all in the vicinity of Pershore, Worcestershire. The fossils in the collection at Apperley Court were carefully examined and named last January by Mr. Boyd Dawkins, the well-known comparative anatomist, and among them we find the remains of two species of elephant, *E. antiquus* and *E. primigenius;* the long haired rhinoceros, *R. tichorhinus;* many fine teeth and bones of a hippopotamus, *H. major*; the remains of two large extinct oxen, *Bos primigenius*, and *Bison priscus*; with many bones and horns of deer, *Cervus elaphus*; all of which were associated with fresh-water shells still living in the Avon, with the exception of the *Unio littoralis*, a Unio which is extinct in Great Britain, although still living in the rivers of France and Spain. It is now ascertained that this group of mammals lived in Great Britain during that period which is known to geologists as the Post-glacial period, a period which succeeded the intense cold of the long Glacial epoch. It must, however, be remembered that the term Post-glacial is rendered in contradistinction to the term Pre-glacial, which is applied to the period which preceded the Glacial epoch; and that it is not to be supposed that the Post-glacial animals existed after the age of glaciers had altogether ceased in Great Britain: for we now know that in Post-glacial times the climate was very severe, though gradually becoming more temperate. There is no greater mistake than to suppose that the term Post-glacial, either as applied to climate or animals, means that the age of glaciers, icebergs, and ice-drifts, or the age of mammoths and rhinoceri had ceased in Great Britain in the times when Post-glacial drifts containing extinct animals were deposited. A few notes, therefore, on some of the principal fossil mammals, and their range in geologic time, may not be uninteresting on the present occasion. Every one who takes any interest in geology knows that no remains of any fossil quadruped have hitherto been detected in the vast thickness of stratified deposits which constitute the mass of strata from the Laurentian to the Permian, inclusive, and which were deposited during the successive geological periods known as the Primary or Palæozoic periods. The older rocks up to the close of the Old Red or Devonian period are all the relics of marine strata, in which the skeletons of land mammalia may have been very rarely preserved if mammals existed: but the same argument hardly applies to the Carboniferous strata, in which land reptiles, land shells, and land insects have been detected; and which afford evidence, at least during the deposition of the coal, of the proximity of land. No mammalia, however, have as yet been detected in any palæozoic rock.

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[1] From the *Worcester Herald*, of July 11th and 18th, 1868.

After the Permian period had passed away a great thickness of strata known as the New Red or Triassic formation were laid down upon the submerged and depressed Palæozoic rocks, and as far as we can judge the New Red formations were deposited, at least in England, in lagoons or salt lakes. This may account for the precipitation of salt at the base of the Lower Keuper marls, as well as for the entire absence of marine shells and the paucity of animal remains of all kinds, with the exception of a few fish spines, the bones and footprints of a few reptiles, and the carapaces of some minute crustaceans (*Estheria*), very similar to allied species which inhabit salt lagoons at the present day. The Triassic rocks of England were however submerged, and are covered up conformably by the Rhætic series, which contain marine shells, a Bone-bed full of the triturated remains of reptiles and fish, and, what is more to our purpose in this paper, the teeth of a small mammal, called *Microlestes*. The teeth of this animal led Dr. Falconer to the conclusion that it was a plant-eating marsupial, such as is the existing kangaroo rat, many species of which feed on plants in the wilds and forests of Australia. At all events, up to the present time, the Upper Triassic rocks, which the Club visited to-day at Wainlode cliff, are the strata which have rendered to the researches of geologists the oldest known mammalian relic upon the face of the globe. The remains of this little animal have been fonnd by Mr. Moore in Somersetshire, near Frome, and by Mr. Boyd Dawkins, near Watchet. It occurs also in the Trias of Germany. It is evident that both the Bone-bed in which the remains of this first known mammal were detected, and the Insect-limestone, made famous by the researches of my friend Mr. Brodie, were shore-deposits, and the Insect-limestone, with its thin layers of mud which preserve so beautifully the delicate forms of the soft bodies and wings of insects, is just the stratum where we should have expected to find the bones and teeth of land animals that strayed by the sea shores of the Triassic epoch. But it is not so. Deeper sea beds, with Nautili and cuttle-fish, gigantic marine reptiles, and fishes of the deep, cover up the Insect-limestone at the base of the Lias; and all the thickness of the Liassic rocks, with a large portion of the Lower Oolites, intervene between the burial-place of the little Triassic quadruped and the Stonesfield slate, which furnishes the remains of the next mammalian animals that are known to the geologists. Now mark the deficiency of the geological record! Unknown and unnumbered ages must have elapsed between the deposition of the Upper Trias and its imbedded *Microlestes*, and the deposition of the Stonesfield slate. The hills of the Cotteswolds are piled mass above mass between them, yet not a mammalian relic do the intervening strata furnish. It is true that those strata were in all probability deposited at a considerable distance from land. Nevertheless we must feel assured that throughout all those periods which elapsed, during which the whole of the Lias and Inferior Oolite beds were deposited, Mammalia of some kind or other must have lived upon the neighbouring shores, but of which not a single fragment has yet been detected. The Stonesfield slate, which lies at the base of the Great Oolite, appears to be either a shore-deposit, or a shore-deposit broken up and redeposited in somewhat deeper water. It contains marine shells, fossil wood, with the impressions of ferns, cones, and other parts of land plants. The remains of insects are sometimes beautifully preserved, and no less than ten jaws of small quadrupeds belonging to three distinct genera have been found in these rocks. All of these animals are believed to have been *Marsupials.*

There are few persons who are not acquainted with the "Purbeck marble," which is so much used for shafts and columns in many of our old English cathedrals and churches. The Purbeck marble belongs to the uppermost division of the Oolite rocks, and is a freshwater limestone, containing freshwater shells and fishes. In the Purbeck series eight or nine genera and about fourteen or fifteen species of plant-eating, insectivorous, and predacious *Marsupials* have been found by Mr. Beckles and Mr. Brodie. Of one of these Mammalia, the *Plagiaulax*, the late Dr. Falconer says that "it may be regarded in the natural system as a marsupial form of rodent," and "may have had the volant habits of the flying *Plalangers*, and flitted from tree to tree among the Oolite forests by means of parachute-folds of their skin." (Falconer's Palæontological Memoirs, vol. ii. p. 425.) These Purbeck Mammalia lived in the same Oolitic period with the strange birds of Solenhofen, birds with tails like lizards (the *Archæopteryx*), and also with the gigantic reptiles that abounded in those days on the land and in the rivers and seas. Yet another change occurred, and we have a long lapse of time, during which all evidence of the existence of Mammals is again wanting. The seas of the Chalk period rolled their waves for ages above the tombs of the Purbeck Mammalia, and with the exception of some winged reptiles (*Pterodactyles*), and a few pieces of drift-wood, all the fossils of the Chalk indicate the existence over a large portion of our northern hemisphere of a wide open sea. During that long protracted epoch, the Secondary epoch, the northern hemisphere appears to have been occupied far more by sea than land, so that the Secondary rocks are, with one or two exceptions, solely the remains of sea-beds widely spread, and deposited in the course of long ages one above the other. With the exception of the freshwater strata of the Wealden and Purbeck beds, the great masses which constitute the Secondary rocks are all of marine origin. No sooner, however, do we examine the *Lower Tertiaries*, than we find evidences of the elevation of land throughout an area over which, during the antecedent period, there rolled the waves of a deep Cretaceous sea, and on this elevated land we know there lived numerous strange and extinct quadrupeds, whose remains are mingled with the relics of extinct reptiles, plants, and shells.

It appears to me that the present school of geologists do not lay sufficient stress upon the gradual elevation of land throughout the northern hemisphere as connected with what I may term the igneous, volcanic, and earthquake forces after the close of the Secondary epoch; and which elevatory forces were destined in the course of unnumbered ages to elevate the sea-beds of the Secondary and the earlier Tertiary epochs on the flanks and even to the summits of the highest mountains in the world. The diminution of volcanic intensity over the portion of the globe we inhabit from the period of the New Red Sandstone up to the close of the Chalk period has not been sufficiently remarked upon: and it is most important to note that it is to the renewal of this volcanic activity and of earthquake movements that so much of the present physical geography of the northern hemisphere owes its origin.

The Eocene Epoch.—Eocene is the term invented by Sir Charles Lyell for the lowest and oldest of the Tertiary rocks which succeed the Secondary rock-masses in stratigraphical position, and in which the prototypes and progenitors of succeeding and existing Mammalia are first known to geologists. Eocene means the shadowing forth or the dawn of those animals whose modified successors in after Miocene, Pliocene, and Post-pliocene times, lived in thousands for long eras on ancient European lands. The points to which I would especially direct attention are the indications afforded by organic remains, by the shells, plants, and animals, of the climate of this part of the world during the Eocene epoch. Everywhere the evidence derivable from the study of the organic remains furnished by the Lower Tertiary Strata of the Continent and Great Britain, is in favour of the existence of a much higher temperature during Eocene times, than now attains in these temperate latitudes. The oldest known Tertiary quadruped is the *Arctocyon primævus* of the Lower Eocenes of Paris, an animal related to the bear, and the Kinkajou or Honey Bear of South America; while in the Lower Eocenes of England there are found the remains of animals which lived *before* that Middle Eocene period, when the great Nummulite formation of marine strata was deposited over a wide sea bed, the strata of which has since been elevated into the mountain chains of the Alps and Pyrenees, the Carpathians, and Himalayas. Many Lower Eocene animals lived and died on the banks of the great river that floated down the tropical fruits of the Isle of Sheppey, in Kent. Among them was the *Coryphodon*, a tapir-like animal, but twice the size of the American tapir, and like it, probably inhabiting densely wooded regions and the banks of rivers. Here also was the *Hyracotherium* of Owen, an animal allied to the rhinoceros and hippopotamus, and whose representatives still linger in the *Hyrax* of the Cape, and the Syrian "coney." Here also are found the bones of *Lophiodon*, an animal which was allied to and was of the size of the tapir, but which appears from its remarkable comparative anatomy to have had affinities connected with its structure which led to the Rhinoceros on one hand, and to the *Palæotheres* on the other. It was probably the prototype of both. The strata of the Upper Eocenes consist, both in England and on the Continent, of a series of both marine and fresh-water strata. The assemblage of shells indicate a more temperate climate, and in the uppermost strata in France, which are probably of later date than the Upper Eocenes of England, the plants indicate distinctly a more temperate climate, as they resemble the vegetation on the borders of the Mediterranean. Still, plants of warm latitudes are associated with those of newer types, as we have the Fan Palm or Palmetto associated with the remains of fresh-water fish, crocodiles, and other reptiles. With regard to the Mammalia the history is most striking. More than fifty extinct species of quadrupeds have been found in rocks of this age in France alone, while many have been found in England. Among these the best known are the *Palæotheres* and *Anoplotheres*, the former being allied to the rhinoceros, the horse, and the tapir; and the latter exhibiting links between the tapirs and camels. With these and many other herbivorous animals there co-existed carnivorous quadrupeds which, says Professor Owen, "to judge by the character of their flesh-cutting teeth, were more fell and deadly than modern wolves and tigers." Not a single quadruped, as far as I know, lived on from the period of the Lower Eocene to that of the Upper Eocenes. New forms modified from the old forms succeed, and we learn that distinct groups of Mammalia lived and died out for ever during the Eocene epoch. (See Lyell's Elements, 6th Ed. 1865).

The Miocene Epoch.—As we ascend from the Lower Tertiary rocks to the Middle Tertiary strata we find evidences of a gradual change in the physical geography and the climate and temperature of this part of the globe, and also of the introduction of new species of animals and plants, and the dying out of the older forms of life; but the change was so gradual that it is most difficult to decide where to draw the line of separation between strata of the Eocene and Miocene epochs, and even now it is found necessary to draw lines of demarcation by the grouping of the fossil Mammalia rather than by the shells and other marine and fresh-water remains. In our English Lower Miocenes of the Isle of Wight remains have been found of the *Hyopotamus*, an early representative of the hog family, extinct species of boar having been found in Germany, which appear to culminate in Post-pliocene deposits in the common wild boar (*Sus scrofa fossilis*). Seven species of Hyopotamus are known. The *Cainotherium* (new beast) of the Lower Miocenes is a genus of quadrupeds distinct, yet allied to the Eocene *Anoplotheres*. A species of Rhinoceros (*R. incisivus*), makes its appearance for the first time in strata of this age. The coming in of new species and the dying out of old ones is well illustrated by the Mammalia of the Upper Miocene deposits. Professor Owen says, "Our knowledge of the progression of Mammalian life during the Miocene period teaches us that one or two of the generic forms most frequent in the older Tertiary strata still lingered on the earth, but that the rest of the Eocene Mammalia had been superseded by new forms, some of which present characters intermediate between those of Eocene and those of Pliocene genera. The *Dinotherium* and narrow-toothed *Mastodon*, for example, diminish the interval between the *Lophiodon* and the elephant," (Owen's Pal., p. 343.) Dr. Falconer also shows how the great *Proboscidians* make their first appearance in the Upper Miocenes, and were represented in Europe by the great *Dinotherium* and *Mastodon*, and in India by three sub-genera of elephants. (Pal. Memoirs, Vol. II., p. 13). The *Dinotherium* was an aquatic animal like the hippopotamus, but allied to the tapir, and had large tusks like those of the walrus, but growing from the under jaw instead of the upper, as if for the purpose of rooting up water plants. The *Mastodons* were like the elephants, with the grinding teeth less complex in structure and "adapted for bruising coarser vegetable substances." (Owen). Four species inhabited Europe in Miocene times, one of which (*Mastodon angustidens*) has left its remains among the fossil pondweeds of the ancient Swiss lake of Œningen. The Pangolins of Africa, and the Manis of tropical Asia, which have now no living representative in Europe, were nevertheless represented in Germany in Miocene times by the *Macrotherium*, an edentate animal which Cuvier calculated must be 24 feet in length. The first evidence of the appearance of the deer-tribe dates from Upper Miocene times, and with these are associated the remains of the lion-like and sabre-toothed *Machairodi*, with species varying in size from that of a lion to the size of a leopard. These powerful carnivora have left their remains in the freshwater beds of Auvergne and of Eppelsheim, and their descendants lived on to Post-glacial times, their teeth having been found among those of the cave animals of Devonshire. Monkeys lived in Miocene days where now the lofty Pyrenees rise, and one of them, the *Dryopithecus* (tree-ape), equalled man in stature. Another, closely allied to the Gibbon, called *Pliopithecus*, has been also discovered in France, and a third, *Semnopithecus*, near Athens. Associated with this monkey were the remains of *Mastodon*, *Dinotheres*, *Hipparion*, *Antilopes*, and two *Giraffes*, the giraffe being now confined to the continent of Africa.

The Pliocene Period.—The Pliocene period is that in which there are more existing species of shells than there are of extinct species, and in the older strata of this age there are nearly as many shells of extinct species as there are of shells whose representatives are still in existence. The fossil mammalia of the Pliocene epoch are little known in England, but have been found in abundance in the continental strata of this age in France and Italy. They differ from those of Miocene times so far, that I believe there is not a single species of quadruped which is common to the Miocene and Pliocene strata of Auvergne. The Miocene genera of Auvergne became extinct before the Pliocene forms were buried in the tuffs, and below the Pliocene lavas, but of all the large assemblage of Pliocene quadrupeds determined by M. Pomel, only two genera, the Mastodon and a large genus of tiger, have become extinct. The Mastodon (*M.*

arvernensis) is common to the Red Crag of England and the Pliocene beds of Italy, but appears to have died out before the deposition of the Forest-bed of Cromer. A species of elephant (*E. meridionalis*) ranges from the older Pliocene times on to the days when it roamed in the Forest of Cromer on the old lands of Norfolk, and is a good example of the long range in time in which the large mammalia inhabited the earth.

Post-Pliocene Deposits.—We now pass upwards to the domain of existing species of shells, and to strata where no extinct species are known of marine shells. Sir Charles Lyell divides the Post-tertiary formations into two groups, the Post-pliocene and the Recent, a necessary division, for in the Post-pliocene formations many of the mammalia belong to extinct species, while the shells are identical with those now living; but in the Recent formations the mammalia, as well as the shells, are identical with existing species. The oldest of the Post-tertiary deposits is the celebrated Forest of Cromer bed, the remains of an old buried forest which has been traced for 40 miles, and which has been covered up by a series of strata, containing in some parts fresh-water shells and land plants, and animals which are themselves covered up by marine strata with marine shells, shewing that both the site of the Post-pliocene forest and the river silts were afterwards depressed beneath the sea. The shells, whether fluviatile or marine, are all of living species. The trees consist of the Scotch and spruce firs, yew, sloe, oak, alder, and birch, with the yellow and white water lilies, the buckbean, the hornwort, and other pond weeds. The fresh-water shells are such as now inhabit the rivers and ponds of England, but both the plants and the shells indicate that the climate when that ancient forest grew was temperate, but, perhaps, somewhat colder than at present. What strikes the geologist and naturalist most are the remains of the mammalia that are found in these beds. They contain the remains of three species of elephant, two species of rhinoceros, a hippopotamus, a gigantic extinct beaver, the great Irish elk (the *Megaceros*), several other kinds of deer, bears, the bison, and several marine mammalia, as the walrus and the narwhal. These great quadrupeds must have lived in abundance on the old forest land when the marine mammalia lived in the sea. But mark what follows. Over the extinct forest, and its extinct quadrupeds, its plants, and its shells, rests the Boulder-clay, the unerring, indubitable witness that the Forest of Cromer and its history was Pre-glacial, that is to say, the intense cold or maximum of the Glacial Epoch had not arrived when the animals lived and the trees and plants flourished; nor had the forest land been submerged beneath a Glacial ocean to receive above them the deposits of melting icebergs, and their deep covering of ice-borne till, and rocks.

The Pre-glacial Brick-earths of the Thames Valley.—It appears that certain strata known as the "Lower Brick-earths of the Thames Valley" are intermediate in time between the Pre-glacial Forest-bed of Cromer and the Glacial Boulder deposits, the mammalia forming a connecting link between the animals of the Forest-bed and those of Post-glacial times. One of the most notable of all the phenomena that occurred during the Glacial epoch is the fact of the submergence of a great portion of the land of Pre-glacial Britain and Western Europe beneath the Glacial seas. The Forest-bed of Cromer was submerged, and the Glacial Boulder-clay rest above it; while certain old river deposits of the Thames Valley appear from the researches of Mr. Boyd Dawkins to belong to a somewhat later period, with a climate comparatively temperate, but colder than that of the Cromer Forest-bed (Quart. Journ. Geol. Soc., vol. xxiii.). Dr. Falconer in 1857 had been struck with the Pliocene assemblage of species in these Lower Brick-earths of the Thames Valley, and had inferred that they were of an earlier age than any part of the Till or Boulder-clay (Quart. Journ. Geol. Soc., vol. xiv., p. 83). It appears that these Thames Brick-earths are covered by a Glacial deposit of angular ice-borne *débris*, as is the Forest-bed by Boulder-clay. The mammalian relics are very abundant, and the assemblage of species found in the river gravels which underlie the Glacial *débris* have led Mr. Boyd Dawkins to draw some very important inferences and conclusions. Three species of elephants having an unequal range in time and space, and all extinct, have been found in these lower Brick-earth deposits. The *Elephas primigenius* (the mammoth) occurs in the Pre-glacial Forest-bed of Norfolk. This animal was well defended during the intense cold of the Glacial period by his long wool and hair, and its remains are most abundant in the Post-glacial strata of Europe and in the frozen gravels of Siberia and North America. *Elephas antiquus* lived in Pliocene times on the continent of Europe, is found abundantly in the Forest-bed of Cromer, and like the Mammoth, lived on to Post-glacial times, but not in such abundance. It is as remarkable, says Mr. Dawkins, for its southern range as the Mammoth is for its northern visitations. It appears "to be a Pliocene species that lived in great numbers in Britain, while the Pre-glacial deposits of the Norfolk shores were being formed, that was gradually supplanted by the Mammoth (*E. primigenius*), and was driven southward by the lowering of the temperature." *Elephas priscus* was a Pliocene species of Italy and Central France, which lived on to the Forest of Cromer period, and the later period of the Thames Brick-earths, but has not been found in Post-glaical strata. Three species of rhinoceros are found in the Brick-earths of the Thames valley but one (*R. megarhinus*), which is a Pliocene animal, and is found in the Forest-bed, does not ascend to the Post-glacial deposits, as do both *R. tichorhinus* and *R. leptorhinus*, which were more adapted to bear severe cold. *R. tichorhinus* was protected like the Mammoth by long wool and hair. The presence of *Elephas priscus* and *Rhinoceros megarhinus*, indicate, says Mr. Dawkins, the affinity of the group of Mammalia from the Brick-earths to those of the Pre-glacial Forest-bed, and to the continental Pliocene strata; but a still more important inference is derived from the absence of that Arctic group of animals which marks the drifts and gravels of Post-glacial times. If the climate of the maximum of the Glacial epoch was intensely cold, so was the climate of the deposition of the Post-glacial river and sea drifts very severe, and gradually becoming temperate as we approach present times. The Post-glacial Arctic Mammalia, such as the Glutton, Lemming, Marmot, Musk Sheep, Elk, and Reindeer, are altogether wanting in the Brick-earths of the Thames. Now it is the presence of these animals that marks the Post-glacial deposits most especially.

The Glacial Epoch.—The next step carries us to the Glacial epoch, the commencement of which was immensely anterior to the deposition of our valley drifts and Cave-deposits. Those who choose to take the trouble to follow out the reasoning and proofs adduced by Sir Charles Lyell will best appreciate the overwhelming evidence he brings to bear on the oscillations during the Glacial epoch, the submergence of continents, and the conversion of continents into islands; and, again, in after periods, the reconversion of sea beds into islands and continents. It was probably during the period of this great gradual submergence that inch by inch, and little by little, some of the great Mammalia of the Pre-glacial continental period were, with the plants and shells, driven southward, and that thousands perished, leaving their skeletons in the frozen drifts of Siberia and the ice-caverns of the far north. It is a problem to be yet solved, whether or not the Mammoth and Rhinoceros of Siberia were all Pre-glacial inhabitants of those arctic regions, whose descendants migrated southwards, and thus the species were preserved in temperate latitudes until Post-glacial times. It is difficult to believe that those animals lived in Siberia in Post-glacial times, for there is little doubt that great cold existed in temperate Europe for long ages after the land had assumed much the same contour which it now possesses. It is not, however, my intention to day, to do more than allude to the Glacial epoch, or the effect of that long era of cold on the northern hemisphere. What I wish to do is to impress upon my hearers the fact that the maximum of intense cold did not arrive suddenly, or as a catastrophic change, but approached gradually; and was brought about by physical changes of sea and land, by the elevation of highlands within the Arctic circle, and, possibly, by astronomical causes assisting; also that these causes were in operation and had commenced in later Tertiary times. There have been few discoveries of late which have so much interested geologists as the discovery of the fact, through the investigation of Professor Heer and other botanists, that during the Miocene epoch a rich flora grew within the arctic zone, in latitudes where now only a vast sheet of ice and snow extends. One hundred and sixty-two species of flowering plants, forest trees, ferns, and cryptogamous plants have been determined, of which no less than 128 species of woody plants alone once flourished in the now icy north; while during the same period we know that in England there flourished, in the neighbourhood of Exeter, cinnamons, vines, figs, laurels, and gigantic Wellingtonias, with tree ferns and other plants, indicating a warm temperature. And to these points I would especially direct attention. The difference of latitude was marked distinctly in Miocene times by the difference between the flowers and trees which grew in the Arctic zone and those that grew on the sites of what is now Devonshire and the Isle of Wight. The latter were more tropical in character. And now we return once more to the Pre-glacial and Post-glacial epochs. The Pre-glacial plants in the Forest-bed of Norfolk, which are found associated with the numerous fossil Mammalia I have already alluded to, are plants that indicate a somewhat colder climate than now exists in Norfolk, as is shown by the presence of Scotch and spruce firs, northern firs which are not now indigenous to Norfolk. In Pre-glacial times we have evidence of the climate being colder than at present, and far colder than in Tertiary days. The Glacial epoch proper succeeds, and this term, "Glacial epoch." should be understood to apply to those unnumbered ages when the cold stole gradually on over Pre-glacial lands and continents, and drove the Mammoth from the frozen North, and wrapped Northern and temperate Europe and the British Isles with snow, and ice, and glaciers, as North Greenland is covered now; also to that later period when much of Northern Europe and the British Isles were submerged beneath the waves of a Glacial sea. The term Post-glacial may apply to those subsequent periods when the present lands re-emerged from the sea, and when, though great cold was still prevalent, and glaciers swept down from every mountain in Wales and Scotland, the climate was ameliorating, and a more temperate change was gradually coming on, until the floating iceberg vanished from the British seas, the glacier melted from the heights of Snowdon, Ben Nevis, and Carran Tual, and the Arctic plants died out among the vales of England to linger only among her mountain tops. But it was before this change from Glacial times that the animals of the Apperley collection lived and died, and left their bones to tell us of their history among the old river-beds and sea-side caves of ancient England. Little by little we gather the fragments of the past, and the geologist, the botanist, and the comparative anatomist, labour to bring the fragments together, and to restore, with some degree of accuracy, the records ot the men, the animals, the plants, and the climate of Europe, which in Post-glacial times preceded our own. And what are those records? Why that in Post-glaical times, when the land of Great Britain was fashioned much as it is now, and the hills rose, and the vales swept down, and the rivers flowed as you now behold them, bitter cold still lingered. The winter's snow and ice filled every valley, the sea-straits were frozen more than half the year round, and the long-haired elephant and rhinoceros, with the musk-ox, the bison, and the elk, roamed over the ice from France and Germany to the downs of Salisbury and Malvern, and along the banks of a frozen Avon, Severn, and Wye. And the hunter man was with them, for, entombed in the old drifts which were deposited by melting ice and snow, or swept down by ice-traversed rivers, or gathered together in caves no longer washed by torrential streams, we find the bones, weapons, and even the ornaments of the rude race which feasted on the mammoth, the rhinoceros, and the bear; and we know that man's intellect was there, for sometimes we find graven the shapes of those extinct mammalia, and graven upon their old bones, to tell us gatherers of these dimly-preserved records that, long ages ago, a representative of God's noblest creature, at least on this planet, lived, and not only lived but reasoned.

REVIEWS.

I.—PALÆONTOLOGICAL MEMOIRS AND NOTES OF THE LATE HUGH FALCONER, A.M., M.D., V.P.R.S., For. Sec. G.S., etc., etc., with a Biographical Sketch of the author. Compiled and edited by CHARLES MURCHISON, M.D., F.R.S., etc. Vol. I., Fauna Antiqua Sivalensis, pp. 590, 34 plates. Vol. II., Mastodon, Elephant, Rhinoceros, Ossiferous Caves, Primeval Man and his Cotemporaries, pp. 675, 38 plates. 8vo. London: Robert Hardwicke, 1868.

THE severest test of friendship is death. Happy is that man, who, after death, shall be borne in kindly remembrance by the friends and comrades of past years. Yet, of these, who would be found willing and able to turn aside from his own pursuits and engage in the task of raising—not a subscription for a bust or statue—but a colossal literary monument to the memory of his departed friend? To the late Dr. Hugh Falconer's memory both these tributes of friendship have been fully paid. Looking back over the three years and a half that have passed away since his death, we recall numerous instances of the way in which his memory lives among us still, and for a literary monument, which will outlast our brief remembrance, the book before us attests both the sterling worth of Falconer's labours, and of Dr. Murchison's friendship.

Volume I. commences with a biographical notice of Dr. Falconer. The sketch of such a life cannot be read without exciting an interest, not only in the man, but in the pursuits to which he devoted his best energies, and may serve as a stimulus to others.

If not already printed as a separate pamphlet, we would suggest to the editor that copies might be so prepared and given away to our public schools and elsewhere with the best results. For if, as Longfellow writes:—

> "Lives of great men all remind us
> We can make our lives sublime,
> And departing leave behind us
> Footprints on the sands of time"—

certainly it may be said of Falconer that he has left behind an example of energetic work and earnest labour in science that many may do well to imitate.

No better illustration can be cited of the way in which Falconer overcame difficulties than that mentioned by Lyell in his address in 1837, on presenting him with the Wollaston Gold Medal of the Geological Society of London (given that year in duplicate to Capt. Cautley and Dr. Falconer). When they failed to obtain Cuvier's works they made for themselves a Museum of Comparative Anatomy, by killing and collecting the skeletons of all the Indian quadrupeds and reptiles they could procure, and thus, while comparing and discriminating the different recent and fossil bones, they were compelled to see and think for themselves.

This volume contains the long-desiderated text to the *Fauna Antiqua Sivalensis*, the plates of which were issued many years since, of folio size, without letter-press. In 34 octavo plates are contained all the most important figures of the Sewalik Hill Fauna reduced in size, and re-drawn by Mr. Dinkel.

The chief of both Sir Proby T. Cautley's and Dr. Falconer's collections are now lodged in the Geological Gallery of the British Museum, and may be seen in Rooms III., V., and VI. No single series, save the *Enaliosauria* of the Lias, occupy so much space or represent so much value, as a collection, as this Sewalik Hill series. Some idea may be formed of the richness of this collection of animal-remains, and the labour involved in its arrangement and description when it is stated that 108 folio plates, executed by Mr. Ford for the original work, contained figures of 1123 specimens (many of which are represented in three, four, or five different views), and that a vast number still remain for future palæontologists to examine.

Besides the description of this grand collection in Vol. I. is also given a geological sketch of the Himalayas, and a description of the Sewalik Hills, where the the Fauna Sivalensis was unearthed; also a report of Falconer's expedition to Cashmeer and Little Tibet, which contain wonderful descriptions of natural scenery, and are full of interest to the physical geologist and traveller.[1]

The second volume has 38 plates of remains of *Mastodon*, *Elephas*, *Rhinoceros*, *Cervus*, etc., etc., in illustration of numerous papers by Falconer, read before the Geological Society and elsewhere; and others edited from his unpublished notes.

The most important paper in this volume is the xxivth., entitled "Primeval Man and his Cotemporaries." This important historical essay was written in 1863, and intended by its author as an introduction to a distinct work with the above title, the object of which was to set forth the physical proofs of the remote antiquity of the human race, and the physical conditions of the earth's crust prior to and at the date of man's first appearance. No one could have been found possessing greater ability and knowledge than Falconer for this undertaking, and, as we read over these thirty pages, we find how completely he was master of his task. To Falconer's extreme caution and the frequency with which he revised and re-studied all his views and observations before committing them to the press, must be attributed the fact that this promising work on primeval man was never completed.

That we owe to him the inauguration of a new era in prehistoric investigation can be clearly shown, for before the exploration of the Brixham Cave at Torquay, no *systematic* examination of ossiferous deposits had ever been carried out. The last task of his great and unwearying life was the exploration and investigation of the fossil contents of the Genista Cave at Gibraltar, in conjunction with Capt. Brome and Mr. George Busk. Returning to England, in order to support, at the Council of the Royal Society, the claims of Charles Darwin for the Copley Medal, he suffered much from exposure to fatigue and cold on the Sierra Morena, owing to the breaking down of the diligence. He attended, for the last time, the Council of the Royal Society, January 19th, and died on 31st January, 1865. His bust is placed in the Royal Society's rooms at Burlington House, and another in the Museum of the Royal Asiatic Society of Bengal. Before long the "Falconer Fellowship" will be founded in the University of Edinburgh, which, with these two volumes, will form his *best* memorials.

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[1] See extract at page 439 of this present number.

II.—MONOGRAPHS PUBLISHED BY THE PALÆONTOGRAPHICAL SOCIETY. June, 1868, Vol. XXI., (Issued for 1867.)

IN the GEOLOGICAL MAGAZINE, 1867, Vol. IV., p. 409, we called attention to the issue in June, 1867, of the twentieth annual volume of the publications of this useful Society: it is with much pleasure that we now refer our readers to vol. xxi., the contents of which are as follows:—

1. On the Flora of the Carboniferous Strata, part i., by E. W. Binney, F.R.S., F.G.S., (with six plates.)
2. Supplement to the Fossil Corals, part iv., No. 2, Liassic Corals, by Dr. P. Martin Duncan, M.B. Lond., F.R.S,, etc., (with six plates.)
3. The Fossil Echinodermata (Cretaceous) vol. i., part ii., by Dr. Thos. Wright, F.R.S.E., F.G.S., (with fourteen plates.)
4. The Fishes of the Old Red Sandstone, part i., by Messrs. J. Powrie, F.G.S., and E. Ray Lankester, (with five plates.)
5. The Pleistocene Mammalia, part ii., *Felis spelæa* continued, by Messrs W. Boyd Dawkins, F.R.S., F.G.S., etc., and W. A. Sanford, F.G.S., (with 14 plates.)

Containing in all 45 lithographic plates (9 of which are double-quarto size,) and 238 quarto pages of text.

1. Mr. BINNEY is a new contributor to the publications of this Society, but his name has been well known for more than twenty years in all matters relating to the Geology and Flora of the Coal-measures. So long ago as 1844, Mr. Binney pointed out (in the Trans. Manchester Philosophical Society) the connection between the "bell-mounds" (*i. e.* the stumps of *Sigillaria*, from which radiated the *Stigmaria ficoides*, the roots of *Sigillaria*,) and the prostrate stems covered with scars and flutings called *Sigillaria*; and he also showed that several species formed upon the leaf-scars of the trunk (as *Sigillaria catenulata*, *reniformis*, *organum*, and *alternans*), were all referable to different conditions of the same stem.

In the valuable memoir published in 1848,[1] "On the Vegetation of the Carboniferous period as compared with that of the present day." Dr. Hooker says, "I am mainly indebted to Mr. Binney for all I know of the most important features of this genus," (*i. e., Sigillaria*) and whose investigations of their habit, mode of growth, and of their connection with the *Stigmariæ*, are beyond all praise." He further adds, "In the Manchester Museum there is a room almost entirely devoted to illustrating the Botany of the Coal formation. The original specimens of some *Sigillariæ*, and models of others of the natural size, collected and transported with great labour, and arranged under Mr. Binney's direction, present to the eye the grandest features of the Coal flora. Accustomed as I had been to see these fossils *in situ*, both in the pits and in quarries, I had previously no adequate conception of their gigantic size, nor of the rapidity with which coal may have been formed, if the tissues of these vegetables were as lax as I suppose them to have been.[1]

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[1] In Vol. II., Part II., Memoirs of the Geological Survey of Great Britain, 1848, pp. 387-456.

The present monograph treats of *Calamites* and *Calamodendron*, and the author premises his own remarks on the specimens figured by a short history of all which has been already written as to these forms. Although the long delay which has occurred in the publication of Mr. Binney's paper has caused other authors to anticipate him to a great extent in the results of his examination of the microscopic structure of these interesting coal-plants, yet the author's observations on their geological position and mode of occurrence in the various beds of Coal are of the greatest value, and the beautiful plates—executed by Mr. J. N. Fitch, mostly from specimens prepared by Mr. Cuttell, whose skill in slicing and mounting sections of fossil wood deserves all praise,—render the monograph of still greater value. We cannot but regret that the author should have adopted for his specimens Brongniart's name *Calamodendron* instead of *Calamites*, the name given by Suckow in 1784, and since accepted by all subsequent writers; the more so, as he says—"no attempt will be made to distinguish the genus *Calamodendron* from the old genus *Calamites*." Let us get rid of all superfluous names from our scientific nomenclature as fast as we can, and if the genera *Asterophyllites*, *Annularia*, *Sphenophyllum*, and *Calamodendron* (with several others), all mean the same thing as *Calamites*,[2] let us make synonyms of them at once.

2. Dr. DUNCAN continues his labours on the Fossil Corals of the Lias, which, as we observed in a former notice (GEOL. MAG., Vol. IV. p. 409), makes us acquainted with an entirely new series of British species.

In the present part the author gives us the history of the Corals from the Zone of *Ammonites angulatus*. He describes and figures *Montlivaltia Ruperti* and *Isastræa Tomesii*, and then discusses the Corals of the British and European Lower Liassic Deposits of the zones of *Ammonites angulatus*, *Ammonites planorbis*, and *Avicula contorta*.

It appears from Dr. Duncan's observations that there was a great development of Coral-life in the Azzarola series (as seen in the south-eastern slopes of the Alps on the Lake of Como, and on the north-western slopes to the south of the Lake of Geneva), but scantily represented in the western and north-western European *Avicula contorta* zones, in the White Lias, and in the zone of *Ammonites planorbis*, followed by another even more luxuriant development of species in the zone of *Ammonites angulatus* (sixty-one species, of which fifty are found in the British Isles), again succeeded by a paucity of species in the zone of *Ammonites Bucklandi*.

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[1] P. 417, op. cit.

[2] For observations upon these interesting plant-remains, see Notice of Dr. Dawson's work on Acadian Geology in GEOLOGICAL MAGAZINE for July last, p. 332.

Dr. Duncan then proceeds to describe in detail the corals of this last-named zone (seven in number); also of the zone of *Ammonites obtusus* (one species), Lower Lias; the zone of *Ammonites raricostatus* (four species), Lower Lias; the zone of *Ammonites Jamesoni* (one species), MiddleLias; the zone of *Ammonites Henleyi* (one species), Middle Lias.

At the end the author adds an account of some corals from the zones of *Amm. planorbis* and *Avicula contorta* (forwarded after the first part of his monograph was finished), and a note on the age of the Brocastle and Sutton stone deposits, etc. Seven woodcuts and six very admirable plates, which reflect the highest credit upon Mr. G. R. De Wilde, complete this useful monograph.

3. Dr. Wright continues his description of the *Echinodermata* from the Chalk and Greensand. From the White Chalk we have figures and diagnoses of *Cidaris hirudo* and *C. intermedia;* from the Grey Chalk, *C. Dixoni*, *C. pleracantha;* from the Sponge-gravel, near Farringdon, Berkshire, *Cidaris Farringdonensis*.

The additional notes on *Cidaris clavigera*, König, with figures of thirteen different forms of spines found attached to this very variable Upper Chalk species; also those on *Cidaris perornata*, and *C. Dixoni*, with figures of the spines of *C. Bowerbankii;* and a note on the *Cidares* of the Red Chalk of Hunstanton and Speeton, at present only known from their spines, are contributed by the Rev. T. Wiltshire, F.G.S., the Honorary Secretary of this Society, who has long collected and studied British Cretaceous Fossils.

Dr. Wright then gives a resumé of M. Cotteau's classification of the *Diademadæ* and proceeds to describe eleven species of *Pseudodiadema* from the Grey Chalk, Gault, and Upper and Lower Greensand. We rejoice to see Dr. Wright has made free use of the pruning-knife, and that, although he has made two new species in this genus, he has made synonyms of twenty old ones.

Of Mr. Bone's plates it is needless to say more than that this veteran artist continues unsurpassed in the charming softness of his plates, which resemble pencil-drawings more than lithography.

4. Mr. James Powrie and Mr. E. Ray Lankester contribute their first part of a Monograph of the Fishes of the Old Red Sandstone of Britain. The present part, on the *Cephalaspidæ*, is undertaken, we observe, by Mr. E. Ray Lankester alone, his colleague Mr. Powrie, being engaged on another portion of their monograph.

In this brief notice we cannot give, as we should wish to do, an outline of this interesting group of fossil fishes,—the earliest of all known forms of *Vertebrata.* The shields of these old fishes are certainly most unlike the ordinary Ichthyic type, and several (as *Cephalaspis, Auchenaspis, Didymaspis,* and *Thyestes*) have a mimetic resemblance to the head-shields of those remarkable Palæozoic Crustacea, classed by Mr. Woodward in the order *Merostomata.* But, examined microscopically, the shield is found to be composed of three layers, the innermost layer having numerous minute osseous *lacunæ* and canaliculi, whilst large vascular canals traverse it very obliquely in their course towards the middle layer; this is covered by a close superficial network of vessels, and is permeated by vascular canals; the outer layer appears structureless, or (like enamel) to be made up of minute fibres. Such a structure as this is wholly unlike that of any known Crustacean.

Several genera of the *Cephalaspidæ* have been referred to other classes. One (*Archæoteuthis dunensis*) having been referred to the Cuttle-fishes, another (*Steganodictyum cornubicum*) to a sponge! etc., etc.

Mr. Lankester thinks the mouth of *Pteraspis* was destitute of teeth, and that it was probably suctorial in form. He places *Scaphaspis, Cythaspis,* and *Pteraspis,* in the Heterostracous section, and *Cephalaspis, Auchenaspis, Didymaspis,* and *Thyestes,* in the Osteostracous section. The five plates which accompany the text are admirably-well and accurately drawn by Mr. Fielding, but there is little beauty for the eye to dwell upon, the chief interest of the specimens consisting in the high antiquity of these Vertebrate remains.

5. Messrs. W. Boyd Dawkins and W. A. Sanford complete the volume with the second part of their monograph on *Felis spelæa.*

Chapter vi. treats of the skull of *Felis spelæa,* every element of which is most carefully compared and described with the greatest accuracy of detail. Chap. vii. is devoted to the Dentition. Chap. viii. deals with the *Vertebræ* and the *Sternum.* Chap. ix. is devoted to the *Scapula.* Chap. x. to the *Humerus.* Chap. xi. to the *Femur.* Chap. xii. to the *Tibia, Fibula,* and *Patella.* To each chapter carefully prepared tables of comparative measurements are appended of all the specimens from the various caverns explored, together with the measurements of the corresponding bones of *Felis leo* and *F. tigris,* in the British Museum. The Plates, 14 in number (including nine double quarto size,) are carefully lithographed by Mr. W. Bidgood, of the Taunton Museum, chiefly from drawings made by Mr. W. A. Sanford. The earnest and laborious efforts of both authors to make their monograph as complete as possible, is everywhere apparent, and no one who has not himself worked at comparative anatomy can fully appreciate the amount of hard work which these seven chapters represent.

Viewed as a mere pecuniary matter, we know of no such a guinea volume in the world as this annual volume of the Palæontographical Society. All who are interested, however slightly, in Geology, should at once join this useful Society, and thus render its power to promote science greater by adding to its means. And, instead of one volume, we may, ere long, receive *two annually!*

III.—Professor Kner's Classification of the Ganoids.

Considered by Dr. Christian Lütken, Assistant Zoologist in the Museum of the University of Copenhagen.

THIS little paper adds to the already well-earned renown of its author as an Ichthyologist; and the subject of which it treats is so important, that the attention of Palæontologists should be drawn to it through the pages of the Geological Magazine.

Professor Kner announces his conviction that the order of Ganoids is not a true natural assemblage; he considers it to be rather opposed to the development of the true natural system. The argument which he puts forth in support of his statement, is that none of the characters which have hitherto been proposed for the order, are precise or exclusive; in fact, it is not, so to speak, properly circumscribed at all. He criticises the definitions given to the Ganoids by Agassiz, J. Müller, Heckel, Pictet, and Owen, showing that the characters proposed are either such that their existence cannot be established in the fossil specimens, or else that they are such as they possess in common with fishes of other orders, or lastly, such as only occur in a more or less limited degree among the various genera commonly regarded as Ganoids,—they are, in short, neither precise nor absolute.

But I think that Prof. Kner goes too far when he claims that every systematic division (especially the higher) shall be founded on precise and absolute characters, such as are without exception, and which they have in common with no other class, order, etc. We must accept the natural divisions as nature herself has established them, and define them as well as we are able. I do not know if Prof. Kner will be capable of giving a single precise and absolute character of a Saurian, a Fish, a Snail, or a Crustacean; but I doubt it very much, and I do not see why the poor Ganoids should be more severely treated than the most natural divisions of the animal kingdom. I heartily agree with Prof. Kner when he writes, "I cannot recognize the order of Ganoids as a natural group at least, not with the limits which are at present given to it, and I believe that its limits are to be drawn in a narrower and sharper manner than hitherto." But he goes further, and states that the fossil Ganoids are not only the ancestors of the living ones, but of all later and recent *Teleostei;* and that those characters, which have been regarded as determining a Ganoid, are simply a common stamp of antiquity impressed upon those primeval types. ("They do not represent a single definite order, but rather the whole amount of development of the recent *Teleostei;* they are the expression of the law of progressive evolution in the class of fishes, whose principal types and great families are already represented among them by the means of prototypes.") Besides, Prof. Kner gives no clue for subdividing the Ganoids and classing them with the more recent families, of which they are the presumed prototypes. The

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[1] [Betrachtungen über die Ganoiden als natisliche Ordnung. Sitzungsberichte d. k. k. Akad. d. Wissench. Wien. Band liv., 1866.]

[illegible] [illegible] [illegible] [illegible] excellent [illegible]. [illegible] [illegible] [illegible] similar [illegible] [illegible] the [illegible] of the [illegible] [illegible] [illegible] with the exception of the Sturgeons and the [illegible]. Mr. [illegible] [illegible] all the other [illegible] [illegible] together [illegible] [illegible] under the common name of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. We [illegible] [illegible] [illegible] the [illegible] with regarding the forms [illegible] [illegible] [illegible] of the recent [illegible] [illegible] [illegible] [illegible] [illegible].

[illegible] the idea of a [illegible] has hitherto been rather vague and [illegible]; many of the [illegible] [illegible] [illegible] and [illegible] have [illegible] in vain to give to this order more [illegible] [illegible] [illegible] [illegible] [illegible]. But if there be any truth in Prof. Kner's views, that Ganoids are only the progenitors of the Teleosts, the immediate ancestors and prototypes of the *Acanthopteri*, *Physostomi*, etc., families of the recent ichthyological system, then they must be a somewhat heterogeneous assemblage of forms, showing but feeble marks of affinity towards each other, and passing insensibly into the most different types of the actual epoch. Is this the answer that the synthetic method would give us, when applied to the present question? I mean that method which, giving up all preconceived ideas, patiently putting genus to genus, until families are formed, and family to family after their natural affinities, until the whole systematic building stands before us? Confiding upon a careful perusal of all the more important publications of the last thirty years on palæichthyology, I venture to give a negative answer to this question. It is my intention shortly to treat this subject more fully. But, in the mean time, I will just state what I believe to be the chief results of the scientific labours bestowed upon that important question,—the systematic arrangement and limitation of Ganoids,—that others who have also studied this subject may have an opportunity of comparing my humble thoughts on the subject with their own results.

The Ganoids form three great divisions or series:—

A. *Lepidosteidæ*, composing all the genera that through their armour of rhombiferous ganoid scales, position of the ventrals, structure of the paired fin, fulcral scales on the fin-borders, presence of true branchiostegal rays, etc., are related to the recent *Lepidostei*. I know of no satisfactory division of this series; that which I should most recommend is the old division into Heterocerci and Homocerci; also taking into account the very different size of the scales. For instance *Cheirolepis*[1] is microlepidote and heterocercal; *Sauropsis*, microlepidote and homocercal; *Palæoniscus*, macrolepidote and heterocercal; *Lepidotus*, macrolepidote and homocercal. But it is very doubtful if any definite limit of demarcation can be drawn between smaller and larger scales, and between heterocercal and sub-homocercal caudal fins, and still more so, if such limits would be at all natural. That no sharp line of demarcation divides the palæocercal and neocercal types is well known. Sub-homocercal *Lepidosteidæ* appeared as early as the "Dyas," and true heterocercal genera continued as far down as the Lias. Like the Ganoids generally, so also this sub-division cannot be defined by any single, precise, or absolute character; the "fulcra" are also found in ancient Teleosteans and *Lepidopleuridæ*, the rhomboidal articulated scales in many *Crossopteri*, etc.; nor are the fulcra discovered in all *Lepidosteidæ*.[1] This division can only be defined in a negative manner, as comprising those rhombiferous Ganoids which have neither the distinctive marks of the *Lepidopleuridæ* nor those of the *Crossopteri*, but which forms nevertheless, as far as I am able to judge, a very natural assemblage of genera.

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[1] Professor Young's discovery of the "jugular plates" of this genus, has made its position somewhat doubtful.

B. *Lepidopleuridæ* or the *Pycnodonts*, easily recognisable by their dermal ribs, and by the peculiar manner in which their scales (when present) are interlocked and attached to those ribs ("lepidopleura"). Each of the three tribes composing this sub-division has its peculiar geological distribution:

a. Pleurosomi	*b. Pleurolepides*	*c. Pycnodontes* (non-fulcrati, homocerci.)	
(fulcrati, heterocerci.)	(fulcrati, homocerci.)	Mesozoic	Neozoic
Carboniferous, Permian.	Liassic.	(Liassic, Oolitic, Cretaceous).[2]	(Cretaceous, Eocene).

The systematic unity of these tribes has been attacked by Heckel and Wagner (two of the chief authors on this group), but it is put beyond doubt by the excellent writings of Egerton and Young.

C. To the great mind of Professor Huxley[3] we owe the establishment of the third sub-division, or that of the *Crossopteri*, distinguished by their "lobate" paired fins, the more or less diphycercal (never homocercal) tail, the absence of branchiostegal rays, the presence of jugular plates, etc. They form five families and two "sub-series."

a. Rhombiferi.	*b. Cycliferi.*
1. *Rhombodipterines* (2 dorsal fins, Devonian and Carboniferous).	3. *Cyclodipterini* (2 dorsal fins, Devonian and Carboniferous).
2. *Polypterini* (a multifid dorsal fin. Recent).	4. *Phaneropleurini* (a single dorsal fin, Devonian and Carboniferous).[4]
	5. *Cœlacanthini*[5] (Carboniferous, Permian, Triassic, Liassic, Oolitic, Cretaceous).

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[1] In *Aspidorhynchus*, where they are generally thought to be wanting, they are nevertheless figured and described by Pictet.

[2] A single species from Lebanon, *Palæobalistum Gœdelii*.

[3] Strange to say, the ingenious "preliminary essay" of this excellent author is far less known among continental palæontologists than it ought to be. No other work since the time of Agassiz's "Recherches" has advanced the progress of Palæichthylogy so much as this admirable book. Will the author forgive my suggesting the slight modification of his arrangement expressed in the terms "*Rhombodipterini*" and "*Cyclodipterini*"? or my intimating that *Gyroptychius* should apparently be removed to the cycloid division of the *Dipterini*?

[4] "*Uronemus lobatus*," Ag. and *Cœlacanthus Münsteri (Permian?)* are said to be related to *Phaneropleuron*.

[5] To the genera enumerated and discussed by Prof. Huxley in his recent monograph

It will not be denied, I believe, that these are the principal natural subdivisions of the Ganoids. and that the three great "series," namely, the *Lepidosteidæ*, *Lepidopleuridæ*, and *Crossopteri*, are closely related, especially through their more ancient types, and cannot be separated, While I would exclude from the Ganoids all other types, *e.g.*, the *Dipnoi* (Lepidosiren), *Sturionidæ*, *Amidæ*; the Jurassic *Teleostei* (Leptolepides) *Megaluri*, *Caturi*, which are peculiar types or simply families of the true *Teleostei Physostomi*; the *Hoplopleuridæ Dercetiformes*,[1] which are true *Teleostei* (*Physoclysti ?*) without Ganoidean affinities; the *Acanthodidæ*, which are, perhaps, better placed with the Selachians; the Placoderms, and *Cephalaspidæ* ("incertæ sedis"), at least provisionally. I would limit the Ganoids (which I regard only as a peculiar sub-order of the *Physostomi*) to the three above-named types, and thus define them :—

"Every fish of the order *Physostomi* (comprising those fish which generally have an air tube, abdominal fins, and soft articulated rays) is a Ganoid, which has either the rhomboidal articulating scales of a *Lepidosteus*; the interlocked scales, attached to the dermal ribs of a *Pycnodont*; the "lobate" fins and jugular plates of a *Polypterus*; or that combines several of these characters."

IV.—Cretaceous Reptiles of the United States.

Under this title Professor Leidy published in 1865, in the Smithsonian Contributions to Knowledge, a monograph of the species of Reptiles then known, from the strata usually called Cretaceous, in New Jersey, Nebraska, Missouri, and other localities in the United States.

It makes known by 120 pages of letterpress and 20 plates, a fauna of 28 species, eight of which find their names in the concluding synopsis: the table of contents enumerates 20 species. Ten of the 28 species find their descriptions here for the first time, and 20 of the species appear to have been first named by Professor Leidy. He states that he has been occupied on the monograph for seven years, and if the result should appear to be slight, we can well understand the difficulty of determining species with the conscientious desire for accuracy which the Professor displays, from the fragmentary materials at his command. Two genera (Mosasaurus and Hadrosaurus) occupy 70 pages, while several, founded on teeth, are rapidly dismissed; such are *Astrodon*, *Tomodon*, *Pliogonodon*, *Polygonodon*, *Trachodon*, *Piratosaurus*. *Polygonodon* presents the form of *Saurocephalus*, for which

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of *Cœlacanthini*, that I have just now been fortunate enough to procure, should be added the Triassic *Graphiurus* of Kner, who will give us some information on the *Hoplopygus* of Agassiz, that appears also to belong to this family (or of the *Gyrosteus*, said to be related to *Chondrosteus*, Eg.). Descriptions of several species of *Undina* that have escaped the attentive care of Prof. Huxley will be found in Wagner's and Throlliere's descriptions of the fishes of the lithographic slates of Bavaria and France.

[1] This singular family is noticed in Pictet and Humbert's "Poissons fossiles du Liban." It is very characteristic of the Cretaceous period. I would nevertheless propose to unite with it the Triassic genera *Belonorhynchus* and *Ichthyorhynchus*, the oldest known (not Ganoidean) *Teleostei*.

the figure of it would well pass. If really reptilian, we should place it among the *Mosasauri;* Professor Leidy suggests that it may belong to either of his genera *Discosaurus* or *Cimoliasaurus*. But these are Plesiosaurs, and with the Plesiosaurian tooth *Polygonodon* has nothing in common. *Pliogonodon* is not figured; the Professor suspects the teeth, without assigning any reason, to have affinity with *Mosasaurus*. To judge from his description of the circular crown, with numerous plicæ on the inside, they would appear to be mere Plesiosaurian. *Tomodon* is thought likely by the author to be a tooth of *Cimoliasaurus* or *Discosaurus*. It is short, flattened and broad, with finely denticulated sharp borders in front and behind. We see no conclusive evidence that *Tomodon* is a reptile; it certainly is as unlike as could be to a Plesiosaur tooth, and is probably Mosasauroid. The resemblance of the tooth called *Piratosaurus* to *Polyptychodon* is noticed, but it is really closer to some of the Plesiosaurs found at the base of the English Oxford clay. *Astrodon* presents, as Professor Leidy remarks, much resemblance to the teeth usually referred to *Hylæosaurus*; we should anticipate that they will prove to be the incisor teeth of *Hadrosaurus*, just as the supposed teeth of *Hylæosaurus* are probably the incisor teeth of *Iguanodon*. *Trachodon* only differs from *Hadrosaurus* in the latter having the edges slightly serrated, and is allowed by Professor Leidy to be probably referable to *Hadrosaurus*. *Discosaurus vetustus* and *Cimoliasaurus magnus* are Plesiosaurian vertebræ of the common Cretaceous type, with flattened articular surfaces, and for all that we can see to the contrary, should both be referred to one species of *Plesiosaurus*; *Cimoliasaurus* is founded on the cervical and dorsal vertebræ; *Discosaurus* on the caudal vertebræ. The species is distinct from any yet published, but apparently most nearly paralleled by one from the English Portland Rock.

Thoracosaurus neocesariensis (de Kay) is the *Crocodilus basifissus* of Professor Owen. It is a true Crocodilian, and has its skull, teeth, and some of the vertebræ figured, and in many details of the skull presents considerable affinities with the Gavial. As the Professor points out, the resemblance is close with the European *Crocodilus macrorhynchus* figured in De Blainvilles' Osteographie. The formation of a distinct genus could perhaps be sustained, but no evidence in favour of such a step is adduced, and we are at a loss to understand on what principle it is constituted, unless it be that every species should be on *à priori* grounds the type of a genus.

Bottosaurus Harlani is the *Crocodilus basitruncatus* of Owen. Professor Agassiz made the genus. It appears to be more truly of the alligator type than the previous species, so far as can be judged from a few teeth, but not an atom of evidence is offered for the formation of a distinct genus.

In the final synopsis two species are added: *Crocodilus tenebrosus* and *C. obscurus*, founded on some specimens referred to in the body of the memoir, but they are not placed in distinct genera.

Polyptychodon is quoted on the evidence of a single tooth, named *P. rugosus*. But *Polyptychodon* teeth are quite undistinguishable from those of *Plesiosaurus*, and the animal appears to have been only a big-headed Plesiosaur with short neck-vertebræ. In these and most other characters (except the trigonal teeth) *Polyptychodon* resembles *Pliosaurus*.

Hyposaurus Rogersi (Owen) has both articular surfaces of the vertebral centrum flattened and slightly concave, with an hypapophysis, sometimes more developed than in the Alligator. In other respects it is apparently a true Crocodile. We do not conceive the flattening of the vertebræ to be important as a mark of affinity, or as a classificational character; but for what it may be worth it is a point of resemblance between *Hyposaurus*, *Steneosaurus*, and *Telesaurus*.

The Chelonians are eight species. *Trionyx priscus* is founded on part of a costal plate. It is of Tertiary type, coarsely marked, and unlike the Trionydian remains from the Cretaceous strata of Europe. *Bothremys Cooki*, this is a very extraordinary Emydian Chelonian; the author compares it to *Podocnemys*, but we are unable to discover more than the faintest affinity with that genus. There are slight indications of affinity with *Trionyx*. There are curious pits in the palatal part of the maxillary which the author suggests may have been for corneous teeth.

There is no evidence that either *Chelone sopita* or *C. ornata* belong to the genus to which they are referred, or that they belong to different species. That specimen referred to *C. sopita* has a decidedly Emydian aspect. A small *Platemys*, indicated by fragments of the plastron, is of the type represented by the London Clay *P. Bowerbankii*. It is the *Emys pravus* of Prof. Leidy. The other Chelonian fragments are too imperfect to make much of, they are named *Emys firmus*, *E. beatus*, and *Platemys sulcatus*.

The article on *Mosasaurus* adds little to our knowledge. The teeth are treated of in great detail, but the only fact of interest demonstrated, previously figured by Goldfuss, is the union between the crown and the osseous pulp, which is quadrate. The chief novelty is a theory of the limbs, in which a humerus of Chelonian character, and smaller bones of the extremities of Plesiosauroid character are referred to *Mosasaurus*. These bones we regard as belonging severally to Emydian Chelonians and to *Plesiosaurus*. Accepting, as Prof. Leidy does, Cuvier's Lacertian interpretation of *Mosasaurus*, a more incongruous thing could not have been done than to refer to it such bones as these, which might have been united to a Crocodile without comment, but not to a Lizard without any evidence of Chelonian affinities. The chief interest of the monograph centres in *Hadrosaurus*, a Dinosaur with teeth of *Iguanodon* type, denticulated at the margin and with one mesial ridge. The vertebræ and limb-bones and ilium, etc., are figured. The material here is all that could be wished; but as in the previous cases our author has been content with topographical description, and has disdained the laurels of the comparative anatomist, except in so far as they are gained by vague suggestions of affinity with *Iguana* and *Iguanodon*. *Hadrosaurus* was kangaroo-like in the proportions of its fore and hind limbs; the affinity with *Iguanodon* is not close. Not a word is said on the affinities with crocodiles; or so far as some points on the hind limb and pelvis go, with struthious birds such as *Dinornis*; and yet with such a bone as the tibia of *Cœlosaurus*, or the ulna of *Hadrosaurus*, it is impossible to think they could be overlooked, even if not suggested by the vertebræ.

Altogether we must, while expressing our thankfulness for the memoir, such as it is, say that it is the least able contribution to palæontology that we remember. Its best praise is that it contains no quackery; its worst condemnation is that it contains no science. It will always be valuable for its plates. We look forward with hope, that remains so precious will some day be elucidated, and doubt not but that the accomplished author of the *Arcitifera* and discoverer of *Lælaps*, will make available to scientific students the descriptions of his Philadelphian brother Professor.

H.

REPORTS AND PROCEEDINGS.

Geological Society of London.—June 17th, 1868.[1]

9. "On some Fossils from the Menevian Group." By J. W. Salter, Esq., A.L.S., F.G.S., and H. Hicks, Esq.

The authors, after describing the localities and stratigraphical relations of the Menevian group, proceeded to describe the following species:—

Paradoxides aurora, Salter, represented by a few imperfect heads, unattached pleuræ, etc. Localities, Porth-y-rhaw and St. David's.

P. Hicksii, Salter. This species presents a singularly intermediate character, reminding us equally of *Paradoxides* and *Anopolenus*.

Conocoryphe bufo, Hicks, represented by a few separate heads, and one with six body-rings attached. Localities, Porth-y-rhaw and St. David's.

C. applanata, Salter. Young specimens show all the metamorphoses observed by Barrande. The characters of such genera as *Agnostus* and *Microdiscus* are as clearly seen in the embryo of *Conocoryphe* as in the adult state of those genera. Localities, Porth-y-rhaw, St. David's, Maentwrog, and Dolgelly,

C. (?) *numerosa*, Salter. Of this species, a part of the head and six thoracic rings have been found. These, however, show characters sufficient to indicate that it is specifically, if not generically, distinct from the others. Localities, Porth-y-rhaw and St. David's.

10. "On Earthquakes in Northern Formosa." By H. F. Holt, Esq., H. M. Consul at Tamsuy. Communicated by the Secretary of State for Foreign Affairs.

The first shock felt in the northern end of the island took place on the morning of the 18th of December, 1867. Many buildings were destroyed and many lives lost in Tamsuy. About fourteen minor shocks were felt during the same day, and on the 20th another violent shock occurred.

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[1] Concluded from the August No. of the Geol. Mag. p. 390.

At Kelung the whole harbour was left dry, and the water, returning in one vast wave, rushed into the town itself. Large landslips have taken place, and several villages between Kelung and Tamsuy have been destroyed.

11. "Memorandum on the Coal-mines of Iwanai, Island of Yesso, Japan." By A. B. Mitford, Esq. Communicated by the Secretary of State for Foreign Affairs.

The mines lie about two miles inland from the village Kaianoma. Four seams of coal have been discovered, which are from one to six feet thick. The coal is soft, yields from ten to twelve per cent. of ash, and from thirty to thirty-five per cent. of gas. It sends out thick black smoke when first lighted, but afterwards burns with a clear strong flame, and leaves no clinker.

12. "On a new species of Fossil Deer from Clacton." By W. Boyd Dawkins, M.A., F.R.S., F.G.S., etc.

This species (named *Cervus Brownii* by the author) is unlike any other species excepting *C. dama*, to which it is closely allied. The antlers, however, have the third tyne present on the anterior portion, while in the Fallow-deer it is entirely absent. From the presence of *Rhinoceros Merkii* and *Elephas antiquus* in the Clacton deposits, and from the absence of Arctic species, the author regarded it as forming a term in the series of strata to which the Lower Brick-earths of the Thames Valley belong, and as deposited before the immigration of Arctic animals into Great Britain.

13. "On a new species of Fossil Deer from the Norwich Crag." By W. Boyd Dawkins, M.A., F.R.S., F.G.S., etc.

Cervus Falconeri, Dawkins, spec. nov. The brow-tyne differs from that of *C. dama* and of *C. Brownii* in being removed from the base, and situated in a different plane from the second and third tynes; in this it is allied to *C. tetraceros*. The straightness of the beam separates it from the species to which he had compaared it; and it is further separated from *C. tetraceros* by the absence of deep wrinkles. The small amount of palmation in *C. Falconeri* is greatly increased in *C. Brownii*, and reaches its maximum in *C. dama*.

14. "Notes to accompany a section of the Strata from the Chalk to the Bembridge Limestone at Whitecliff Bay, Isle of Wight." By T. Codrington, Esq., F.G.S.

In these notes the author described in detail the beds which are comprised in the section exhibited in Whitecliff Bay, and which he had carefully measured at low water. Comparing it with the Alum Bay section measured by the officers of the Geological Survey, he found the total thickness of the beds from the Chalk to the base of the Fluvio-marine series to be the same in both, although the thicknesses of the component formations differ considerably.

15. "On the Graptolites of the Coniston Flags, with notes on the British species of the genus *Graptolites*." By Dr. H. A. Nicholson, M.B., F.G.S., etc.

The author, after remarking upon the prevalent differences of opinion regarding the stratigraphical position of the Coniston Flags, proceeded to describe the following species:—

Diplograpsus palmeus, Barr.
D. folium, His.
D. angustifolius, Hall.
D. confertus, Nich.
D. tamariscus, Nich.
D. pristis, His.
Retiolites perlatus, Nich., *nov. sp.*
Rastrites Linnæi, Barr.
Climacograpsus (*Diplograpsus*) *teretiusculus*, His.
Rastrites peregrinus, Barr.
Graptolites lobiferus, M'Coy.
Graptolites Sedgwickii, Portl.
G. fimbriatus, Nich.
G. Nilssoni, Barr.
G. tenuis, Portl.
G. discretus, Nich.
G. Bohemicus, Barr.
G. priodon, Bronn.
G. colonus, Barr.
G. sagittarius, Linn.
G. turriculatus.
G. Sedgwickii, Portl.
var. spinigenis, Nich.

16. "On the 'Waterstone Beds' of the Keuper, and on Pseudomorphous Crystals of Chloride of Sodium." By G. W. Ormerod, Esq., M.A., F.G.S.

Between Salcomb Mouth and the River Sid, and between Budleigh Salterton and Littleham Bay, several beds of ripple-marked "Waterstone" occur, and also pseudomorphous crystals of chloride of sodium. A small fragment of Waterstone exhibited apparently traces of reptilian remains. In conclusion, the author drew attention to the fact that pseudomorphs occur over the greater part of the Triassic area in England.

17. "On the discovery of the remains of Pteraspidian Fishes in Devonshire and Cornwall, and on the identity of *Steganodictyum cornubicum*, M'Coy, with *Scaphaspis* (*Archæoteuthis*) *Dunensis*, Rœmer." By E. Ray Lankester, Esq.

A specimen labelled "*Pteraspis*," from the Lower Devonian slates of Mudstone Bay, in the collection of the late Mr. Wyatt-Edgell, was at once referred by Mr. Salter to the *Steganodictyum* of M'Coy; and on further research, he concluded that M'Coy's supposed sponge is actually the cephalic plate of a Pteraspidian fish. The author fully endorsed Mr. Salter's determination, and inferred that the specimens of *Steganodictyum Carteri* are really head-plates of true *Cephalaspis*.

18. "On the Geological peculiarities of that part of Central Germany known as the Saxon Switzerland." By the late Capt. James Clark. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.R.S., etc.

The author described in detail the rocks of which the district under consideration is composed; namely, 1, the Upper Quader Sandstone; 2, Pläner Limestone; 3, Pläner Marl; 4, Lower Quader Sandstone; and gave a list of their chief fossils.

The peculiarities of this region consist, first, in the abrupt and marked variations of altitude without any corresponding inclination or dislocation of the strata. Secondly, in the remarkable regularity of the fissures by which the rocks are divided, which cross them at right angles. Thirdly, in the phenomena observable along the line of separation between the Quader and the Lusatian granite; the Quader being overlain by the granite and syenite. Fourthly, in the disposition of the basalt, which rises through the granite and the stratified rocks above, indurating the latter, but not contorting them.

The next evening meeting of the Society will be held on November 11th.

CORRESPONDENCE.

ON THE STRATA, NEAR ELY.

Sir,—Mr. Seeley's humorous communication in your August Number, p. 347, has called attention to a paper which I read at Cambridge more than eighteen months ago, but which has only quite lately been printed. Thinking any interest it might have had would have passed away, I have hitherto sent out no copies of it, but I now enclose one to you.[1]

It is fortunate for Cambridge men that they have so near them a section on which differences of opinion may exist; and, if ever the old system of the schools should be revived, a lively disputation might be held in excellent dog-latin on Roswell pit, at Ely.

This is one of those cases where any one who wishes to form an opinion must go and see for himself. Mr. Seeley and his class of students may come to one conclusion, and other observers may surely differ from them without offence.

O. FISHER.

Harlton, Cambridge,
4th August, 1868.

THE CHALK OF ANTRIM.

Sir,—It will no doubt be a source of much pleasure to many of your readers to find my friend Professor Jukes entering an appearance at last for the geology of the North of Ireland, and giving us the first instalment, as he did, upon a subject of great interest in your last number. I have no fear but that, in his hands, and those of Mr. Du Noyer, the subject will be exhausted.

Permit me, however, as an observer here to say a word, and ask for some little more light before we abandon, or even finally adopt, the received theory upon the subject of Professor Jukes's article. The phenomena alluded to are seen near this place, where the white limestone occurs with the basalt of Benyevenagh, etc., near the mouth of the Foyle. Now I do think that the concentric coloured bands of the flints may hereafter admit of some better explanation than that of the action of heat, but I object to the deduction of Professor Jukes from the observed facts.

He argues that the basalt (4 in his diagram) could not have indurated the limestone without altering the lignite and clay, and he quotes in the P.S. an experiment, showing that the lignite was so volatile, when treated with red heat in a platinum capsule, as to lose 75.8 per cent. of its weight.

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[1] We have reprinted it at p. 407 of the present Number, so that our readers have now the entire case before them as it stands.—Edit.

We often find lignite in the state described in the indurated Carboniferous rocks themselves, and here we may get some little inkling as to the nature of metamorphic action.

We know that the basalt (4) was very hot; that the lignite clay (3) was hot too; that the flint bed (2) was hot also; and that the limestone (1) was at least very warm. At the time of this basaltic outburst the whole district affected by it must have had a very high temperature indeed, and the lime was deposited in a pasty mass. Now why the lignite was not altered it is not necessary to discuss here. I think a satisfactory reason can be shown, but I will only remark that volatilizing matter in a compressed bed of clay, and in a "platinum capsule," are two very different things; but a strong heat transmitted through the clay (but not sufficient to indurate it) would be quite sufficient to indurate a paste of lime below it. I for one do not believe in the necessity for very great heat in metamorphic action. It has been observed that many substances (minerals) seem only to have to be brought into close contact, to be changed, under pressure, from loose particles to solid rocks.

In a rough way, we observe this, when we break up the rich limestones of the Co. Cork for instance, for road metal, and leave them for years subject to pressure (which is convertible into heat), and when we afterwards break up the mass, we find we have to quarry an exceedingly hard breccia or conglomerate, and can scarcely even disturb it with a pickaxe; but take the basalts or earthy rocks (of which bed 3 in diagram is only the waste), and all we can do will not make a compact mass of them.

We have then ample reason for admitting that the transmitted heat of the superincumbent mass could affect and indurate the lime below, but we must guard cautiously against the idea that the alteration, or induration, or metamorphism of rocks, can only be affected by a fierce heat. It remains yet to be shown that the basalt and the induration of the white limestone "are not connected in the way of cause and effect."

Looking forward with much pleasure and confidence to the labours of Professor Jukes in this new field in Ireland.—I am, &c.,

WILLIAM HARTE, C.E.,
County Surveyor of Donegal.

County Surveyor's Office, Buncrana, Co. Donegal,
10th August, 1868.

MISCELLANEOUS.

DR. FALCONER ON THE HIMALAYAHS.[1]—"The rock formations of the Himalayahs are all primary; the Sub-Himalayan is very recent.

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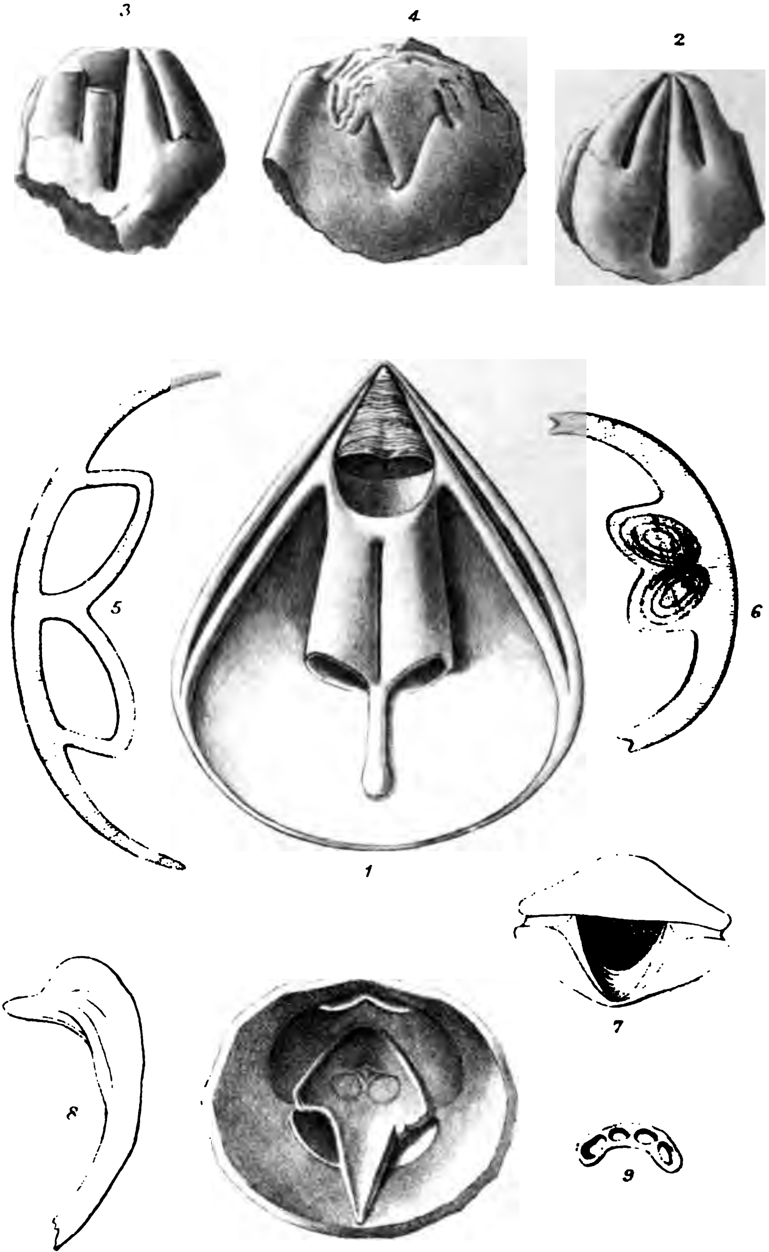
[1] Extract from a letter written by the late Dr. Hugh Falconer, in 1834, to the Rev. Dr. Gordon, of Birnie, N.B., soon after his return from ascending the Jumnootree as far as the hot springs at the sources of the Jumna. See Biographical Sketch, p. xxxi., Falconer's Palæontological Memoirs, vol. i.; reviewed in the present No. of this MAGAZINE, p. 423.

In the outer ridges you get limestone and the newer primary rocks (transition). As you go on, gneiss, mica-slate, etc., succeed. In the outer ridges the volcanic rocks are greenstone traps (I believe I was the first to make this out), often with porphyritic crystals, and here and there unstratified quartz rock. As you go inwards you get granite and syenite. On the southern side of the snow peaks there are more recent formations, and I should not have said that the Himalayahs are *entirely* primary. You there get limestone with *Ammonites*, *Orthoceratites*, *Trilobitæ*, and *Terebratulæ*, as in the Mountain Limestone of England. The snowy range, or central ridge, has an elevation varying from 15,000 to 26,000 feet. Perhaps the mean height may be from 18,500 to 19,000. The snowy mountains are not, as in the Andes, interrupted by peaks here and there of porphyries and other traps, but a continuous line of ridges, and the highest of them are certainly primary schists, such as gneiss, etc. You may remember, perhaps, Jameson's doubts about this point. But I am convinced that they are only huge masses of the same formation as the lower ridges, upheaved to a greater elevation. The scenery is magnificent, like Byron's ocean, 'boundless, endless, and sublime;' huge, vast, and awe-striking. To give you an idea of some of the views: I got up on the top of a high mountain, called Choor, half way between the snowy range and the plains, with an elevation of about 13,000 feet. In front, looking to the north, the eye took in a continuous line of snowy ridges, varying from 15,000 to 24,000 feet, or no less than 90° on a quadrant of the horizon. This is no exaggeration. Between me and them stretched an ocean of mountain waves, I overtopping all. In the rear, or south, stretched another sea of mountain-ridges, with the plains of India in the distance, level as a lake, traversed here and there by a streak of silver, marking the tiny show made by the mighty rivers Jumna and Ganges, and then, turning to right and left, was a stretch of ridge upon ridge and of mountain upon mountain, bounded only by the limits of vision. I stood upon pinnacled masses of granite which made a noble and harmonious offset to the whole. Follow me, on another occasion, to the source of the river Jumna, at the foot of the mountain Jumnootree, 21,000 feet high, I walking in the bed of the river, in a narrow winding channel cutting off the view in every direction, with a lofty wall of rock on either hand. Imagine now a sudden bend of the channel, opening a vista in front, and the mountain bursting on the view, rising nearly two miles in height right over me, its black front patched over and its summit crested with snow, looking like an enormous wave curling with foam and rolling on to overwhelm us. So vivid was this impression, that astounded awe was the first feeling, and it required an exertion of reason to get over it."



E. Fielding lith

W West imp.

Trimerella, Billings.

Upper Silurian, Island of Gotland.

THE

GEOLOGICAL MAGAZINE.

No. LII.—OCTOBER, 1868.

ORIGINAL ARTICLES:

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I.—On the Genus *Trimerella*, Billings.[1]

By Dr. Gustav Lindström, of the University of Wisby, in the Island of Gotland.

[PLATE XX.]

MANY beds of limestone, belonging to the middle division of the Upper Silurian formation of the Island of Gotland, consist almost entirely of the fragments of a very large and peculiarly-shaped Brachiopodous shell. It may be regarded as one of the most characteristic fossils of these Upper Silurian rocks. Perfect valves, giving a satisfactory view of its structure have never been found. When Mr. Davidson, with his usual kindness, sent me copies of the figures and descriptions given by Mr. Billings,[2] of the new genus *Trimerella*, found in Canada, I had no hesitation in referring both the Canadian and the Gothlandic shells to the same genus. The materials obtained by Mr. Billings seem to have been more incomplete than mine; I have, therefore, been able to make some additions to the description given by him.

The greatest peculiarity consists in two siphons or tubes, that penetrate the shell along the median axis of the valves, or on both sides of it. These siphons, by degrees, taper off, and cease in the vicinity of the apex of the valves; their openings are of an ovate oblique form on the interior surface of the valves, and almost in the centre. An elevated shield, hiding the continuation of the siphons in its interior, is formed by the concentric shell-layers that envelop the siphons (Plate XX., Fig. 6), and, on the surface, by the mantle and other soft parts. This median elevation is smooth, having no impressions of muscular parts, and is deeply concave along the median axis. The lateral walls of both siphons are contiguous to the median axis of the valve, and continue as a straight ridge for a considerable distance down towards the inferior margin of the valve. The soft parts that secreted the concentric layers of the siphons, by degrees moved downward during the growth of the animal, filling the place they once occupied with shelly matter. Thus we find the apices of the siphons are generally filled with concentric layers. Some faint longitudinal striæ are seen on the interior walls of the siphons. The concentric layers around the siphons form two strata that are quite distinct from the rest of the shell-matter, and are imbedded in it. They cannot, therefore, be confounded with septa, which, when they do occur in the shells, are in immediate contact with the valves, and compactly united with them. The siphons of the dorsal valve are shorter than those in the ventral valve, and often more divergent. I think we gain the true interpretation of the nature of these siphons, if we attentively examine the interior surface of the valves in the genera *Lingula* and *Obolus*. The corresponding part of the valve of *Lingula* is occupied by two impressions of the adductors, situated on each side of a broad, faint, shield-like elevation.

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[1] Translated and communicated by the Author from the "Ofversigt af Kongl. Vetenskaps-Akademiens Förhandlingar," 1867. No. 5. pp. 258–257.

[2] Billings, Geol. Survey of Canada, Pal. Foss., Vol. I., p. 167.

In some of the Silurian *Lingulæ* these muscular impressions[1] are somewhat excavated in the valve.

The straight ridge, that continues below the impressions of the adductors, and to which in the recent *Lingulæ* the "*occlusores anteriores*," Owen ("anterior retractors," Woodward), are fixed, is, as it seems to me, homologous to the median ridge, continuing so far below the openings of the siphons. This ridge consists (in *Trimerella*) of two layers, that extend towards the margins of the valves, and are an immediate continuation of the siphonal layers. In *Obolus* the adductors occupy the same place as in *Lingula*, but are separated by a larger elevation, or median shield. In some of the Upper Silurian *Oboli* (which, perhaps, form a separate genus), this median shield is very much elevated and prolonged in a long narrow ridge, as in *Lingula*. In these *Oboli* the impressions of the adductors are deeply hollowed in the valves, so that the casts resemble two very short and pointed teeth.[2] But this peculiar form of the muscular scars is fully developed in *Trimerella*. I consider these characteristic siphons to be the muscular scars, because their openings occupy the same places as the adductors in the above-named genera, and also because the walls are marked with those longitudinal striæ so characteristic of the muscular impressions; they have, moreover, a mode of development quite different from that of the septa. There can, then, be discerned an almost continuous series in this development of the muscular scars; faintly indicated in the *Lingulæ*, strongly expressed in *Obolus* (more especially in those from the Upper Silurian rocks), and fully developed in *Trimerella*. No other vestiges of muscular impressions are visible, excepting those on both sides of the elongated median ridge, and probably the narrow impressions going from the exterior margin of the adductors towards the margins of the valves. It is also possible that muscles were attached in the apical corners of the ventral valve.

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[1] Davidson, Silurian *Brachiopoda*, pl. ii., fig. 35; pl. iii., figs. 5, 6.

[2] Davidson (l. c. pl. iv., fig. 39). Compare also fig. 4 of my plate with the figure of a dorsal valve of *Trimerella grandis* in the work of Mr. Billings.

My above stated opinion as to the nature of the siphons of *Trimerella* is corroborated by the fact that in some species of *Crania*, especially the Cretaceous, these scars of the adductors continue in the form of narrow pointed siphons, ceasing at the apex of the valves. Thus, for instance, in *Crania spinulosa*, Hisinger, Leth. Suecica, pl. xxiv., fig. 7*a*; also, *C. Brattenburgensis*, in the German edition of Davidson's "Introduction to the *Brachiopoda*," pl. v., fig. 15, and *C. antiqua*, Defr., pl. v., fig. 16c. I can also cite the valuable authority of the late Dr. S. P. Woodward, in his "Manual of the Mollusca," p. 236 (*Crania*), "The large muscular impressions are . . . sometimes deeply excavated."

If, however, *Trimerella*, by reason of the structure of its median muscular impressions, is related to the *Lingulidæ*, it is widely separated from them in another respect, as its dorsal valve is provided with a large tongue-shaped process (possibly the processus cardinalis ?), by means of which it is articulated to the ventral valve. This process fits into a semilunar groove below the area of the ventral valve, and this area is formed by the lamellæ, that one by one have been secreted above the semilunar groove (Pl. XX. Fig. 7).

Another anomaly of which I have not seen any homology amongst the *Brachiopoda*, is that the lateral margins of both valves are grooved by a furrow, shallow at the ends and deepest in the centre. These furrows encircle the opposite margins, and make the valves close more tightly.

The valves attain a thickness of 15 millimètres, and consist in their perfect state of calcareous spar, and show no traces of any organic structure.

EXPLANATION OF PLATE XX.

Fig. 1. Interior of ventral valve restored.
„ 2, 3. Casts of both valves.
„ 4. Cast of dorsal valve of *Obolus ? Davidsoni*, Salter (Gotland).
„ 5. Section of ventral valve at the openings of the siphons.
„ 6. Section of the same showing the concentric calcareous secretions around the siphons.
„ 7. Cardinal process of dorsal valve fixed in the ventral valve.
„ 8. Side view of dorsal valve.
„ 9. Section of ventral valve at the apex.
„ 10. Interior of the dorsal valve of *Obolus*, sp. from a cast in gutta-percha.

II.—On some Cavities in the Gravel of the Valley of the Little Ouse, in Norfolk.[1]

By John Evans, F.R.S., F.S.A., Sec. Geol. Soc.

A FEW months ago both geologists and archæologists, and especially the latter, were surprised to hear of the discovery in the valley of the Little Ouse, between Thetford and Brandon, of certain cavities in beds of gravel, in which flint implements of the forms peculiar to the Palæolithic or river gravel were found, and which it seemed possible might have been the habitations of the early race of men who formed these implements.

An account of this discovery was communicated to the Norwich Geological Society, and also to the Norfolk and Norwich Archæological Society, by Mr. Sheriff Fitch, F.S.A., F.G.S., to whom the credit of first observing these cavities is due, and who I was in hopes would have made a communication on the subject instead of leaving it for me to do.

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[1] Read before Section C. of the British Association, Norwich, August 23rd, 1868.

From Mr. Fitch's account it appears that at Santon Downham and Broom Hill, two of the places where gravel is dug between Thetford and Brandon, holes or excavations occur in the beds of gravel at about ten feet from the surface. The beds of gravel in the immediate neighbourhood of these cavities are said to be disturbed, so that the workmen know when they are approaching them, and the implements were said by the workmen to be found lying at the bottom of these holes.

Mr. Fitch had an opportunity of seeing one of these cavities opened in the pit near Santon Downham. It was large enough to allow him to stand inside, a layer of dark clay lined the bottom of the hole, and this formed a basin-shaped floor. Its roof was beautifully rounded and smooth, and had all the appearance of design, and on excavating at the bottom, a flint implement of a Palæolithic type was found.

The workmen maintained that there was little chance of finding implements, unless when working near, or in similar holes, of which some fifteen have been found within a limited space.

Mr. Fitch, while contenting himself with stating bare facts, and without trusting himself to any theory, could not but say that the appearances presented were exceedingly suggestive. He adds that "one cannot help thinking that it looks very much like a colony, and if these holes are of human handiwork, it must bring the age of the flint implements considerably nearer to the Historic epoch than has been usually attributed to them, for the excavation of the holes must necessarily be of later date than the gravel beds in which they occur.

"Elsewhere, as at Brixham, Torquay, and other localities in England and on the continent, caves in the solid rocks have yielded implements, and the occurrence of wrought holes in the hard gravels indicate a similarity of habit as regards the choice of dwelling-places, for we must allow that even these primitive men needed shelter from the inclement climate of that distant period.

"It seems to me, that if we are to discover human bones at all, these caves are the likeliest spots to look for them.

"At Broom Hill, bones are frequently found in the made earth or 'trail,' but not in the underlying gravels.

"The caves have had some communication one with another, for we are safe in presuming that wherever man lived, he was always a gregarious or social being."

Like many others, I was of course much interested in this report, though I could not regard the question in the same light as those who had personally witnessed the phenomena. I at once wrote to Mr. Fitch, suggesting a possible cause for the existence of such cavities, and requesting him to give me notice of the next occasion on which one of them was found capable of examination.

In the meantime, my friend, Mr. J. W. Flower, came down to Norwich, and on his way back to London, he stopped at Brandon, and found that in the Broom Hill pit, about a mile and a half from Brandon station, the workmen had come across one of these cavities, which, however, with the exception of a small opening in it, was left entirely undisturbed. On hearing of this discovery I immediately arranged to go down and examine into the phenomena, and accordingly, on the 8th of July, Mr. Flower, Mr. Fitch, and I met upon the spot. We found a face of gravel and sand exposed, about 24 feet in height from the chalk at its base to the superficial soil at the summit. The upper part of the section showed sand with a few gravelly seams, about eight or ten feet in thickness; at the base of this occurred a dark band of ferruginous argillaceous sand a few inches in thickness, then some eight or nine feet of ochreous gravel, with a red sandy matrix, which was separated by a band of grey sand from the lower beds of gravel which contained a very large percentage of rolled Chalk and seams of chalky sand.

The opening into the cavity was not much more than a foot in diameter, and was about the middle of the bed of ochreous gravel. It was soon sufficiently enlarged to enable one of us to creep in, and by the aid of a candle to examine the cavity. It was slightly irregular in form, and seemed about three feet in diameter and about five feet in height, but we did not take any accurate measurements, as we were in constant fear, and not without reason, of the face of the cliff of gravel falling in upon us. The bottom of the cavity had some sand upon it, which had fallen from the roof, the cavity extending upwards through the gravel, so that its ceiling was formed by the base of the sands above. The axis of the cavity was not quite perpendicular. Having examined it as far as was consistent with safety, we next commenced cutting a vertical groove in the face of the gravel below, with a view of ascertaining whether, as I had suspected, there was not a sandpipe below, the absorption of the gravel into which was the primary cause of the cavity. The second blow of the pickaxe broke through the wall of gravel and at once revealed a sandpipe, thus proving my view to have been correct.

We at once proceeded to clear it out as far as was consistent with safety, and found that at about three feet above the base of the gravel the pipe was about two feet in diameter and nearly circular, but whether it descended into the Chalk we were unable to see, and before we left the pit the face of the gravel cliff gave way, and the scene of our operations was buried under a mass many tons in weight. During our examination of the pipe, and while we were speaking of the occurrence of flint implements in these cavities, one of the pointed form was found under our eyes by one of the workmen among the gravel he was clearing out of the pipe.

The existence of this sandpipe below the cavity, similar in character to the pipes so frequently occurring in sands and gravels overlying calcareous strata, at once proved that these cavities were of natural and not of artificial origin. As, however, such cavities are of extremely rare occurrence, and have not, I believe, been previously noticed except by Mr. Fitch, who did not enter into the question of their origin, it will be well to devote a short time to a consideration of the causes to which they are due.

Mr. Prestwich was, I think, the first to point out that such pipes in the Chalk are due to the percolation of water charged with carbonic acid derived from the decomposition of vegetable matter, which dissolves the calcareous portion of the Chalk, leaving any argillaceous particles behind, with which, and with the superincumbent gravel, sand, or clay, which descends as the calcareous matter beneath is removed, the pipes are usually filled. The arrangement of the matter enclosed in the pipes and of the bands of flints through which they sometimes pass, proves the correctness of Mr. Prestwich's views. The general action of the carbonated water on calcareous strata is evinced by similar pipes occurring in Oolitic beds, such for instance as the celebrated natural wells near P[illegible] and in the Coralline Crag of Suffolk, which in some places, as in a pit not far from the Railway Station at Aldeburgh, is absolutely riddled with such pipes. And not only have such pipes been formed in this manner, but the whole upper surface of the Chalk, where covered by beds of gravel, appears in many instances to have been so eroded that the beds which would seem to have been originally laid out horizontally on an approximately smooth base, now rest upon a rough and irregular surface full of peaks and hollows. Where, as is sometimes the case, the gravel in pits has been cleared away completely, so as to leave the upper surface of the Chalk bare, a sort of model of a mountainous country is presented to our eyes.

We have seen that in nearly all cases the pipes that have been thus gradually eroded, have been filled by the superincumbent beds gradually following down, but we can readily conceive instances in which some one or other of the upper beds might be so tenacious as not to subside into the hollow beneath until a large superficial area was left unsupported. The result in such a case would be a cavern of greater or less magnitude, from the bottom of which proceeded a pipe passing through calcareous rock, and filled with the remains of the less tenacious beds underlying the more unyielding bed, which would form the ceiling of the cavern. These conditions were fulfilled in the cavity in the Broom Hill Pit, where the tenacious bed was the sand with the compact argillaceous band at its base, the incoherent beds which filled the pipe were the ochreous gravel and sands, and the pipe was eroded through the calcareous gravel, and probably into the Chalk itself. Since then, in fact within the last few days, I have had another opportunity of visiting the pits at Santon Downham, of there inspecting one of the caves, which, however, it was not possible thoroughly to investigate. Only the upper part of the cavity was visible, of a regular vaulted form, the sides being formed of coarse incoherent gravel, while the roof or ceiling consisted of a much finer gravel, with a more coherent matrix of red sand. The bottom of the cavity was at the time filled with coarse gravel fallen in from the sides, and there was no opportunity of observing whether there was any sandpipe at the bottom, though no doubt such was the case. In the wall of gravel close by, there were two sandpipes in which the upper beds had followed down in the usual manner.

With regard to the supposed almost exclusive occurrence of the flint implements in connection with these cavities, it is to be observed—1st. That the evidence of such being the case is not susceptible of cross-examination, and moreover that one of the workmen remarked to Mr. Fitch and me on what he regarded as a singular fact, that no implements were found in these holes; and, 2ndly, that if the pits were found in the proportion of 12 or 15 to an area of a few score square yards, as has been stated, and implements were found at all, it would be singular indeed if they were not found either near or in the cavities, with which too the workmen would naturally associate them. As a matter of fact, however, the implements do occur in other parts of the gravel than in or near the cavities, and some of those at Broom Hill have occurred in the lower gravel with the calcareous matrix.

It is, however, *à priori* improbable that such a gravel, a great part of the constituents of which appears to have been derived from the destruction of some river bluff, should contain so many relics of human handiwork as gravels derived from the washing away of some once-inhabited surface.

If, however, it be true, as is generally believed and asserted, that the flint implements occur in most abundance at the base of these fluviatile gravels with a sandy nature, there is a reason why they should be found not unfrequently in the pipes into which, of course these lower beds of the gravel would be let down. I have known instances at Thetford where the gravel has been extracted from potholes running down into the Chalk, and in which implements have been found at a considerable depth. The celebrated pit at Drucat, in the valley of the Somme, affords another instance of implements occurring in these pipes.

Mr. Prestwich has already, in his valuable memoir communicated to the Royal Society, suggested that these pipes may eventually afford some means of estimating the antiquity of the beds in which they occur. It is, however, extremely difficult to ascertain the exact amount of carbonic acid which, on an average of years, the percolating water of each year would contain. Could we, however, ascertain the exact drainage area of one of these pipes, I think that some sort of calculation might be made. For we know by experiment the number of inches of rain which, with our present climate, percolate annually to the springs in a Chalk district, while we also know the quantity of chalk in solution held by each gallon of the spring water. It must, however, be borne in mind that in all probability the maximum quantity of carbonate of lime in solution is not attained until after the water has percolated a considerable distance through the Chalk. But without entering into any such calculation, I think it must be evident that a cavity large enough "to hold a cart inside," eroded by the carbonic acid of vegetable matter decaying on the surface, and carried down by the rain, implies a lapse of time for its erosion such as is quite in accordance with the antiquity which from other considerations must be assigned to these beds, containing as they do the undoubted handiwork of our barbaric forefathers.—Reprinted from the *Norfolk News*, August 25th, 1868.

III.—ON THE IDENTITY OF *HETEROPHYLLIA LYELLI* AND *H. MIRABILIS* OF DUNCAN.

By JOHN YOUNG, Curator of the Hunterian Museum, Glasgow.

IN a paper published in the Proceedings of the Royal Society of London,[1] Dr. Duncan has figured and described six new species of Carboniferous corals, belonging to the genus *Heterophyllia* of M'Coy, from specimens found in Scottish Carboniferous limestone strata. Of these species two *H. Lyelli* and *H. mirabilis*, seem to be founded on portions, which the careful examination of better preserved specimens would have shown to belong to only one good species.

I would not have ventured to make the following remarks upon these corals, had not the localities from whence they are obtained been long and familiarly known to me; and I am satisfied, after a careful examination of more than 50 specimens, large and small, and in all states of preservation, that they all belong to one species, in which the external characters and internal structure vary to a certain extent.

In order to show the close connection that exists between these two so-called species, I will quote Dr. Duncan's description of the corals, side by side, with the parts numbered, so that the points of specific distinction may be more easily perceived, and will then make my remarks in support of what I consider their identity.

Heterophyllia Lyelli, sp. nov., Duncan.	*Heterophyllia mirabilis*, sp. nov., Duncan.
1st. The corallum is very long, very slender, and is slightly bent.	1st. The corallum is tall, very slender, and nearly straight.
2nd. The costæ are large, smooth, and rounded; they project, and are marked with occasional tubercles, pits, and grooves.	2nd. The costæ are narrow, rounded, smooth, and slightly projecting; they have tubercles at regular and frequent intervals. These tubercles are rounded and oblique, and project slightly. To each of them is articulated a curved hook-shaped process, which stands out from the costa and the tubercles, its concavity being directed inwards and downwards.
3rd. The intercostal spaces are wide and shallow, and equal; they are slightly concave, and are marked with festoon-shaped ridges or lines.	3rd. The intercostal spaces are shallow, wide, and usually convex, but occasionally concave; they are marked with three longitudinal delicate shallow grooves, with very slightly rounded longitudinal eminences between them. A groove is central.
4th. The horizontal section of the corallum is hexagonal in outline; the wall is stout and thick, and only very slightly concave between the costæ.	4th. The horizontal section of the corallum is nearly circular; there are projections which correspond with the costæ; and the wall is moderately thick.
5th. The surface of the corallum is smooth and plain.	5th. The surface of the corallum is smooth.

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[1] On the Genera *Heterophyllia*, *Battersbyia*, *Palæocyclus*, and *Asterosmilia*; the Anatomy of their Species, and their position in the Classification of the *Sclerodermic Zoantharia*. By P. Martin Duncan, M.B. Lond., F.G.S., Secretary to the Geological Society.—Read May 2, 1867.

6th. There are six septa, which are united by a linear septal columella.	6th. There are six septa, which are united by a linear septal columella.
7th. The endotheca is tolerably abundant.	7th. The endotheca is scanty, and the dissepiments are wide apart.
8th. The diameter of the corallum is 1-10th inch or less.	8th. The diameter of the corallum is rather more than 1-20th inch.
9th. In the Carboniferous limestone of Craigenglen, Stirling, and Brockley, Lesmahagow, Lanarkshire.	9th. From the Carboniferous limestone of Craigenglen and Brockley.

From the above descriptions it will be seen that the two species, as described by Dr. Duncan, have many characters in common, and I am satisfied that, had he examined a larger number of specimens, he would have found every variety connecting them.

In the first place this coral has never, so far as I am aware, been found with its extremities perfect, fragments occur from three to four inches in length, but generally it is found in shorter pieces; these are of every diameter between $\frac{1}{10}$ and $\frac{1}{40}$ inch or less. One specimen, $3\frac{1}{4}$ inches in length, tapers in that distance from $\frac{1}{18}$ to $\frac{1}{80}$ inch in diameter, showing that measurements from fragments of various sizes are of no specific value.

All the larger specimens are more or less flexuous, some of them being much curved, and occasionally bent at right angles; this is the case with both stout and slender specimens of the corallum.

The curved hook-shaped processes which are described as one of the principal specific characters of *H. mirabilis*, I consider as of no value in distinguishing that species, for we possess specimens of every diameter as formerly quoted, showing these little hooklets. On nearly every specimen which is found embedded in the shale they may be exposed with careful manipulation. Indeed it seems to have been the perfect condition of the corallum, large or small. In weathered specimens of the stems, found lying upon the shale-banks, the hooklets are always broken off, but their bases may still be traced upon the costæ, or in the grooves to which they were fixed.

Dr. Duncan states that *H. Lyelli* is only occasionally tuberculated, but the specimen of this species which he figures in pl. xxxi., fig. 4, c., is as regularly tuberculated as that shown in his figures of *H. mirabilis*. Except in very much worn specimens, the tubercles are always present upon both large and small diameters of the corallum, and as they are sometimes seen to vary slightly in number and regularity, even upon parts of the same stem, mere irregularity of occurrence is not, therefore, to be considered of any specific value.

The costæ and intercostal spaces are also characters that vary considerably in this coral, and cannot, I think, be depended upon as points of specific distinction, as some specimens of the largest diameter have costæ less developed than those seen upon more moderately-sized stems. The intercostal spaces are wide, shallow, or deep, according to the diameter of the specimen, and the prominence of the costæ.

In *H. Lyelli*, the horizontal section of the corallum is stated to be hexagonal, in *H. mirabilis*, mostly circular; this is a point that appears to me of no value in the diagnosis of the species, as the section varies with the prominence of the costæ and the convexity or concavity of the intercostal spaces, and this variation may sometimes be seen upon the same specimen. In general, the greatest number of specimens of all the various diameters met with, approach the hexagonal form; one specimen, however, in my collection shows, in a cross section, a stellate or six-sided angular form, and another well marked fragment is quadrangular in section, having four small tuberculated costæ. Internally this specimen has only four septa corresponding with the costæ, instead of six, the normal number. Other specimens occur which show a nearly circular section, and on some of these, instead of costæ, we have only longitudinal grooves to the floor of which the hooklets were fixed. These differences in the external form of the stem of the corallum I consider to be mere exceptional variations of one species.

The endotheca and dissepiments are also characters that vary. In many specimens the endotheca has either never been well developed or has been destroyed by the crystallization of the internal structure of the corallum. The dissepiments are stated to be wide apart, but one longitudinal section shows 30 in the length of one inch, being less than one half line apart.

It will be seen from the above remarks that this coral varies, to a certain extent, both in its external form and internal structure, many of its parts depending upon the state of preservation in which we find the specimens. It seems to me that Dr. Duncan has taken the specific characters of *H. Lyelli* from the lower portion of a stem with the hooklets broken off and slightly worn, and his *H. mirabilis* from the upper or more slender part of a stem, as seen lying in the shale, with the hooklets in position.

There is one important mistake which Dr. Duncan has committed in his description of *H. mirabilis*, to which I wish shortly to refer. He states that the curved hook-shaped spines or processes, which stand out from the costæ, were articulated to the tubercles upon the costæ, and he gives several figures to illustrate what he supposes was their mode of attachment. This view is not warranted by an examination of several fine specimens in my own collection and in that of Mr. James Armstrong, which are embedded in shale, and show the hooklets in position.

These were not hooklets articulated upon tubercles, but small, curved, spinous processes immoveably attached to the stem, either upon the costæ or in grooves. At their base these processes seem to have been tubular, and when broken off and a little worn, as seen in weathered specimens, they then present a deceptive appearance as of a small rounded tubercle, with a pit in the centre, which is caused by the hollow base of the spine.

In nearly every specimen in which these delicate little hooklets are preserved in position, they are seen to be fractured close to their attachment with the stem. This has been produced by the pressure to which the corallum was subjected while lying in the soft shale. It is easily seen from the irregular way in which they are fractured, that they were broken off by pressure, and not by any process of disarticulation. On some specimens there is still to be seen, at rare intervals, a single spine attached by its solid base to the stem, while on numerous other examples, where the hooklets have not been fractured quite close to the stems, their bases are seen projecting a short distance from the costæ. In one specimen the hooklet has been broken off near the stem, but the matrix retains a cast of the detached spine; the contour of which, from base to apex, is perfectly even and unbroken, an appearance incompatible with the alleged mode of attachment. The above facts clearly show that there was no articulation of their bases upon rounded tubercles, which would, it appears to me, be quite an anomaly in the structure of a zoophyte.

A specimen of what seems to have been a fragment of this coral was figured by David Ure in his Natural History of Rutherglen and East Kilbride, in the year 1793, pl. xix., fig. 11. Ure does not describe the specimen further than by stating that it was beautiful on account of its denticulation, and that it was rare. He placed it among his Coralloides.

Prof. M'Coy's *Serpula hexicarinata* evidently belongs to this coral, or to a closely allied species of *Heterophyllia.* His specimen seems to have shown no internal structure, nor any of the external spinous processes: this led him to conclude that it was some anomalous species of *Serpula.* The absence of structure and external markings, may have been due to the specimen having been preserved in a crystalline limestone. M'Coy thus defines the organism in his Carboniferous fossils of Ireland. "*Serpula hexicarinata,* pl. xxiii., fig. 28, sp. ch. Elongate, slightly flexuous, hexagonal; sides nearly equal, smooth, flat; rounded, prominent keel on each of the angles. This species is easily distinguished from any other of the Palæozoic *Serpulæ,* by the hexagonal form of the tube, and the six, narrow, rounded keels on the angles. Length usually about two inches, width half a line."

So closely does the above description answer to small, worn specimens of *H. mirabilis,* that my specimens were long identified with M'Coy's fossil, and as such appeared with his name in my lists with a (?), as I was satisfied that it could not belong to the genus *Serpula,* but was a zoophyte closely allied to other forms I had found at Brockley near Lesmahagow, which Dr. Duncan has now placed, no doubt correctly, among Professor M'Coy's *Heterophyllia.*[1]

Craigenglen, Campsie, has yielded the finest preserved specimens of the coral under discussion, and as these specimens seem to prove the identity of the two so-called species, one of the specific names adopted by Dr. Duncan must be allowed to drop. I would, therefore, suggest that that of *H. mirabilis* be the one retained, as it is given to the specimen which represents the most perfect condition of the coral.

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[1] In the Catalogue of the collection of fossils in the Museum of Practical Geology, page 129, *Serpula hexagona* is mentioned from the Glasgow district. Unfortunately as the authorities for the species are not given in that work, I am unable to state whether that species be the same as M'Coy's *S. hexicarinata.* But I suspect that it is, and if so, then it must be referred to the genus of corals in question, for I know of no hexagonal form of *Serpula* from the Carboniferous strata of Scotland, especially from the Glasgow district, with the fossils of which I am well acquainted.

NOTICES OF MEMOIRS.

Abstract of a Paper on "The Glacial and Post-glacial Structure of Norfolk and Suffolk." By Messrs. Searles V. Wood, Junr., and F. W. Harmer.[1]

(Read before the British Association at Norwich, August 20, 1868.)

THIS paper was a summary of the results arrived at by the authors, from a survey and mapping of the Crag and Glacial beds of Norfolk and Suffolk, upon the Ordnance (one inch to the mile) map, which they have been carrying on during the last four years. The paper was illustrated with a large map, constructed from their survey map, and copious detailed sections, traversing the counties in various directions, without which the paper itself is difficult to be understood. The principal results at which the authors have arrived at are as follows:—

That the Fluvio-marine Crag of Thorpe, and Bramerton, and of Wangford, Bulchamp, and Thorpe, near Aldboro', is coeval with the newer part of the Red Crag.

That the Crag of Burgh, Horstead, and Coltishall, in the Bure Valley, is a fluvio-marine development of the Chillesford shell bed, or Crag of Easton and Aldeby, which, divided from the Red and Fluvio-marine Crag by an interval of sand of varying thickness, overlies the Red Crag at Chillesford, and the Fluvio-marine Crag (or old Norwich Crag) at Thorpe and Bramerton.

That the so-called Crag of Belaugh, in the Bure Valley, and the so-called Crag of the Weybourne and Cromer coast, are newer than the Chillesford beds (which, unless the pebble beds next mentioned be a still higher part of the Crag series, form the uppermost of the true Crag series), being characterised by the presence in profusion of a shell unknown to any bed of the true Crag series from the Chillesford clay downwards—viz., the *Tellina solidula;* and were introduced after an elevation of the Crag area had converted the southern portion of it into land, and given rise over the northern portion to extensive sands with pebble beds, which rest on and indent the Chillesford clay in that northern portion. These sands with pebbles occupy in the south of Norfolk, and north of Suffolk, the same place relatively to the contorted Drift as is occupied on the Cromer coast by the Weybourne sand (or so-called "Crag" of the Cromer coast), the Cromer Till, and the indenting sand (or bed C after-mentioned). These pebble beds may thus represent in time either the whole or any one of the formations A, B, and C (described further on); or they may form merely the closing bed of the true Crag series,[2] in which case the Weybourne sand, the Cromer Till, and bed C are entirely unrepresented in the south of Norfolk and north of Suffolk.

That the forest beds of the coast extending from Eccles to

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[1] The abstract has been most obligingly prepared and furnished by the authors expressly for publication in the Geological Magazine.—Edit.

[2] The authors are inclined to think that the second of these alternatives is the true one; and they hope to clear up the point by means of a fossiliferous pebble-bed near Bungay.

Weybourne, with their associated sandy clays of freshwater origin, (being the oldest beds exposed along that coast, and having been partially destroyed by the denudation of the sea depositing the so-called Crag containing *Tellina solidula*), represent a land surface of some period anterior to this so-called Crag. That as this period extends from the close of the true Crag series downwards, such land surface may be either contemporaneous with the true Crag series (which has no place on the northern coast of Norfolk), or may be of a period intervening between the close of that series and the actual submergence of northern Norfolk, which was accompanied by the introduction of *Tellina solidula*, and the accumulation of the Weybourne sand, or so-called "Crag" of the Cromer coast.[1]

That the Mammalian teeth and jaw fragments of *terrestrial* Mammalia (generally more or less rolled), obtained as yet from the Fluvio-marine Crag and Chillesford beds, do not represent the Mammalian fauna of the deposit in which they occur, but are derivative from some older bed.

That, contrary to the views of the Rev. John Gunn and others, who discover an Upper and Lower Boulder-clay in the cliffs between Weybourne and Eccles, and identify the former with the great Boulder-clay formation of the East of England, the authors regard everything in those cliffs as inferior, not only to the great Boulder-clay, but also to the extensive sands and gravels termed by them Middle Glacial; these sands and gravels (which underlie a large part of the great Boulder-clay in the counties of Norfolk, Suffolk, Essex, Hertford, Buckingham, and Leicester,) only capping with their base the cliffs in places, but in greater mass forming the sand hills, which immediately inland occupy higher ground than the top of the cliffs, and are spread extensively over northern Norfolk.

That all the beds of the cliff-section between Eccles and Weybourne (except the patches of the base of the Middle Glacial sands, which in places cap it,) form a series of themselves which they term the Lower Glacial, and are throughout characterised by the presence of *Tellina solidula*. These are divisible into the following, which are given in the *ascending* order.

A.—The Weybourne Sand, the base of which, when resting on the Chalk, is often occupied by an accumulation of shell-patches known to collectors as "The Norwich Crag" of the coast. This sand becomes, east of Cromer, charged with lignite, and often laminated with bands of lignitiferous clay, in which condition it constitutes the "laminated series" of the Rev. John Gunn. In that condition it is unfossiliferous, the lignite intermixture apparently rendering it unsuited for molluscan life, of which the remains are usually present when in its pure condition. This sand passes up by interbedding into :—

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[1] The authors would observe that the position of the bed yielding wood and Mammalian remains beneath the Middle Glacial sands at Kessingland Cliff in Suffolk, seems, from its position relatively to the Chillesford Clay, two miles distant, to be clearly subsequent to the close of the Crag series; but whether this bed be synchronous with the whole of the Forest and freshwater deposits of the Cromer coast, or whether the latter may not represent a much longer duration of land surface—a duration embracing the period of the Kessingland bed, but reaching back into the Crag period—must be determined by the palæontological evidence only.

B.—The Cromer Till, or "Lower Boulder-clay" of Mr. Gunn, a sandy clay with numerous small stones, and with occasionally a boulder of larger dimensions.

C.—Sands which, where the cliff is uncontorted, are seen to be indented into a deeply eroded surface of the Till, and to have themselves been also denuded, so as to form an even floor for the ensuing formation, viz.,

D.—The Contorted Drift. This bed is the widest spread of the Lower Glacial series. It begins in the north of Suffolk as a reddish brown brick-earth, a few feet thick, resting on the sands with pebbles, before described, but sometimes the pebbly sands have been removed. It comes up at the base of Pakefield and Corton cliffs (where, as well as in the sections at Bishops Bridge, Norwich, it is called by Mr. Gunn and others "Lower Boulder-clay,") and thickening rapidly as it extends northwards, comes out at the eastern termination of the Cromer coast section at Eccles, as the well-known Contorted Drift of that coast, from whence it extends continuously, and as the uppermost bed of the cliff (except the sand cappings) to Weybourne. The authors state that they have traced it from its attenuated commencement in the north-east of Suffolk and south-east of Norfolk in every direction northwards, and found it at Cargate Green, near Acle (ten miles only south of the Cromer coast), overlaid by the great Boulder-clay (or Upper Glacial), and at West Somerton (seven miles south-east of the Eccles termination of the coast section) overlaid by Middle Glacial sand, and that again by the great Boulder-clay in direct superposition. In its brick-earth condition it is sometimes full of small stones, occasionally also of minute chalk fragments, and often contains large sand-galls. In the direction of Weybourne this deposit becomes more marly by the intermixture of fine chalk sediment; and west of Mundesley, at which place it begins to be contorted, great masses of pure white marl or reconstructed Chalk (which have been described as chalk-masses by observers,) occur in it, which, by the weight of the bergs carrying them, have sunk in some cases into the subjacent Till, and even into the Weybourne sand. These marl masses the authors describe as being detached fragments from the more inland portion of the Contorted Drift itself; which, inland from the coast, both southwards towards Reepham and Holt, and westwards towards Wells, becomes formed exclusively of this marl. They attribute the formation of this marly portion of the Contorted Drift to a discharge of ground-up Chalk from the *debouchure* of a Glacier that occupied the Chalk country of Cambridgeshire and West Suffolk; the brick-earth which forms the easterly development of the Contorted Drift, being due to a river discharge in that part; the two sediments intermingling in the intermediate area, and producing the alternations of marl and brick-earth there presented by this formation. The detached masses of the marl were, they consider, introduced into the brick-earth portion of the deposit by the agency of bergs, which, breaking from the Glacier and grounding, picked up masses of the marl forming over the sea-bottom in that part of the area. These masses the bergs carried out into the area where the brick-earth was accumulating, and grounding again, imbedded them in the brick-earth, and even in the subjacent Till and Weybourne Sand, contorting the beds in the process. From detached portions of this marl, which they have found as far south as Claydon, near Ipswich, and Stanstead, near Lavenham, in Suffolk, they infer that this deposit covered the west of Suffolk and Norfolk, but underwent great denudation in the former part by the waters of the Middle Glacial sea, the sands of that sea, west and south of Diss, lying up to bosses of it in some parts, and overlying it in others.

That the fauna of the lower Glacial beds is marked by the disappearance of all except the boreal and arctic mollusca of the Crag, rather than by the introduction of a new fauna, the principal introduction being the *Tellina solidula.* A list of 28 species of mollusca was given by the authors from these lower Glacial beds.

That the sands and gravels, attaining frequently a thickness of fifty or sixty feet, which underlie much of the great Boulder-clay in the six counties before-mentioned, and which, termed by the authors the Middle Glacial, pass over the Lower Glacial series, A, B, C, and D, just described, contain a molluscan fauna of which they enumerate 23 species. The interest attaching to this fauna consists in the fact that *Pectunculus glycimeris*, which dies out in the newer part of the Red Crag, and is excessively rare in the Fluvio-marine or true Norwich Crag, returned during this formation in abundance, as well as *Ostrea edulis*, a shell which similarly disappears in the newer beds of the Crag, and it is not known now within the Arctic circle. Although a bed, a few feet thick, of Boulder-clay identical in composition with the great Boulder-clay, but of very limited extent, occurs at the base of this formation at two places in north-east Suffolk and at one place in Hertfordshire, its features and fauna both appear to indicate that some considerable amelioration of the very severe climate to which the marl of the Contorted Drift that preceded it was due, occurred in the interval occupied by this formation.

That the true wide-spread Boulder-clay of the east of England, termed by the authors, the Upper Glacial, ceases from denudation in northern Norfolk, along a line drawn from Winterton on the north-east coast to Norwich, and thence passing near Aylsham through Cawston, Guestwick, and Barney, to a point a little north of Fakenham. On the east of the county, that is to say, to the south-east of a line joining Norwich and Happisburgh, the Middle Glacial sand and the underlying contorted Drift crop out from beneath the true Boulder-clay, in regular sequence; but over the centre of Norfolk the authors describe a very anomalous structure, which is that the true Boulder-clay (or Upper Glacial) has been deposited in a great trough more than twenty miles wide, which has been excavated through the Middle Glacial sands and subjacent Lower Glacial beds down to the Chalk. The effect of this has been to bring the true Boulder-clay (or Upper Glacial), resting on the Chalk, down to a level on the west and south-west of Norwich, which in some parts is below that of the Crag, and nearly 100 feet below the position which it occupies when resting on the older Glacial beds in undisturbed sequence of deposit, the Chalk upon which the Upper Glacial thus rests direct, being generally in a glaciated or disturbed condition.

That over the central part of Norfolk, where the Upper Glacial thus goes down in solid mass to the Chalk, it is overspread by extensive beds of Post-glacial gravel,[1] which not only cap the plateau but spread over the sides of the valleys, sometimes forming a continuous wrapping sheet down to their bottoms, and presenting general absence of terrace structure. These features the authors consider as repugnant to any theory accounting for the excavation the valleys by river-action. Similar old Post-glacial gravels a also present, but less extensively, in eastern Norfolk, where th rest on the denuded surfaces of the Upper and Middle Glacial formations; large sheets of them capping the former at Poringland, a the latter at Mousehold Heath.

That, in addition to these older gravels, sheets of a newer grav more or less concealed by the alluvium, occupy the bottoms of m of the river-valleys. This newer gravel they consider may be t deposits of the rivers during the Post-Glacial period, and after t valleys had been formed by tidal action.

The sequence of the beds, omitting the Post-Glacial, may summed up as follows, the beds being taken in descending order:

1. The Upper Glacial, or true Boulder-clay, of the East of England
2. The Middle Glacial sands and gravels
3. The Contorted Drift, beginning as a thin bed in the North-east of Suffolk, and thickening out towards the Norfolk coast } Part of Glacia Series
4. The Pebbly sands and Pebble beds.
5. The Chillesford Clay
6 Sands containing the Chillesford *shell-bed*, or *Crag* of Chillesford, Sudbourn Church Walks, Easton Cliff, and Aldeby, and Upper bed of Bramerton
7. The Red and Fluvio-marine Crag } True Up Crag Ser

The Weybourn sand (A), the Cromer Till (B), and the indenting sand (C). (wh with the contorted drift make up the Lower Glacial formation), come in below the No. 3, which spreads over them and over No. 4; but as they are absent wh No. 4 is present they, as before explained, may either represent No. 4, or No. 4 m be only the uppermost member of the true Crag series.

In South-east Suffolk No. 2 rests on 5, 6, or 7, but most frequently on No. Nos. 5 and 6 having been much denuded prior to the deposit of No. 2.

REVIEWS.

I.—A Journey in Brazil. By Professor and Mrs. Louis Agassi Boston: Ticknor and Fields. London: Trübner and Co., Paternoster Row. 1868. 8vo. pp. 540, with 20 woodcut engravings.

"To Mr. Nathaniel Thayer, the friend who made it possible give this journey the character of a scientific expedition, th present volume is gratefully inscribed." Thus reads the dedication, and we presently learn that when, in the winter of 1865, it became necessary for Professor Agassiz to seek a change of climate, he began to brood over his long-cherished wish to visit Brazil. Single-handed, this journey, however pleasant as a vacation, would produce very little result, and would thus possess no charm for him. Under these circumstances, and while the Professor was still in a state of perplexity, he met Mr. Nathaniel Thayer, who said in reference to the proposed journey:—"You wish, of course, to give it a scientific character; take six assistants with you, and I will be responsible for all their expenses, personal and scientific." We can well believe that the Professor doubted at first whether he had heard rightly. Such generosity is not of every-day occurrence, and is the more unusual, from the simple, unostentatious manner in which it was offered, and the large and liberal manner in which it was carried out.

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[1] In the small map of the Glacial beds of the east of England, printed by one the authors for private circulation in 1865, the centre of Norfolk, where these Pos glacial sands and gravels so extensively occur, was represented as principally occupi by the sands and gravels of the Middle Glacial series. This error, which the pros eution of their work has detected, the authors desire to call to notice.

This volume does not profess to contain the results of the expedition; many of them have to be worked out, and may require years of labour to evolve. What it professes to be, and what it really consists of, is a journal or diary written by Mrs. Agassiz, with interspersed remarks by the Professor; he was in the habit of giving her daily the more general results of his scientific observations; and, in a few places, we find a scientific essay, which has evidently been written by him.

The journey was from Rio de Janeiro, up the Amazon to Tabatinga, and back to Manaos. From this place excursions were made up the tributaries of the Amazon, and finally the party returned to Rio, after the lapse of more than a twelvemonth.

It would be next to impossible for any observing naturalist to spend a whole year on the Amazon without finding something astonishing; but we question whether many men would have found the marvels there which Professor Agassiz seems to have done. We have nothing to do with the 2000 species of fishes which he states that he has collected, nor with the 200 species which inhabit, and are nearly confined to, a small pond covering a space of not more than four or five hundred square yards. All this sort of thing must be provisionally accepted until the figures and descriptions are published, and then we shall expect the Zoologists to say something about them. What we, as Geologists, have to do with, is Prof. Agassiz's assertion that, during the Glacial periods, the whole valley of the Amazon and its tributaries was occupied by an enormous glacier.

Let us now endeavour to follow Professor Agassiz in his wonderful interpretation of the geological history of the valley of the Amazon.

This valley was first sketched out by the elevation of two tracts of land; namely, the plateau of Guiana on the north, and the central plateau of Brazil on the south. At a later period the upheaval of the Andes took place, closing the western side of this strait, and thus transforming it into a gulf open only towards the east. At the close of the Secondary period, the whole Amazonian basin (including in this term the provinces of Ceará, Pianhy, and Maranham) became lined with a Cretaceous deposit, which crops out at various [illegible] along its borders. It is thus a Cretaceous basin. Of the Tertiary period there is no representative known, as the succeeding formations are of later date. These are three in number, the oldest of which is rarely visible, but consists of sandstone or stratified sand; upon this rests everywhere an extensive deposit of finely-laminated clays (sometimes looking like clay-slates), which have yielded fossil leaves closely resembling those of plants living in the region. The second formation, (formerly referred either to the Old Red or the Trias) consists of beds of sand and sandstone, frequently false-bedded, presenting a variety of aspects, and being very variable in thickness: in some places forming isolated hills 800 feet in height, and in others being represented by a mere remnant. The third and uppermost deposit is clayey, containing more or less sand, and reddish in colour. In the upper portion of the valley it is obscurely stratified, and its materials are small; but near Rio, it contains large stones. Almost everywhere its base is marked by a bed of small pebbles, and it reposes unconformably on the underlying formation. Professor Agassiz, however, has convinced himself that they were deposited by the same water-system within the same basin, but at different levels.

The extent of these formations is something marvellous, but so i the explanation of their origin.

Professor Agassiz believes that all these deposits belong to th ice-period in its earlier or later phases. He infers that the valley the Amazon had an enormous glacier poured down into it fr the accumulations of snow in the Cordilleras, and swollen laterall by the tributary glaciers descending from the table-lands of Guia and Brazil. Its movement was eastward, it ploughed up an ground down the bottom of the valley, and it built up as its termin moraine a colossal sea-wall of gigantic proportions. But there a no furrows, no striæ, no polishing. Professor Agassiz replie because there are no natural rock-surfaces; and there are *rock moutonnées* and boulders. The climate then became milder, and th glacier partially melted, transforming the basin with its sea-wa into a vast fresh-water lake, covered with a thick crust of ic Under these circumstances were deposited the coarse pebbly san and the superposed finely laminated clays. Our author expects be here reminded of his fossil leaves and their tropical character, an he makes a very poor reply,—for the vegetation of Switzerland, o the borders of glaciers, to which he appeals, is certainly not tropica

The second formation belongs to a later period, when the whol body of ice being more or less thawed, the basin contained a larg quantity of water; and we are asked to believe that under these ci cumstances a sandstone formation was deposited, here and ther false-bedded, and attaining a thickness of 800 feet. At the end o this time, the sea is supposed to have worn away the terminal morain so as to release this vast body of water, which consequently rushe violently seaward, denuding the sandstone it had just deposite except in a few places where it left the flat-topped "denudatio hill" of the Sierra of Ereré. The basin was not, however, entirely emptied, and a period of quiet accumulation again set in, during which the third formation was deposited, and the boulders of Ereré were carried to their resting place either by the last remnants of the ice-field, or by icebergs dropped into the basin from glaciers still remaining in the Andes, etc.

The only reason which Professor Agassiz can adduce for not regarding these formations as marine, is that he found no marine fossils. But we ask—How many years was the North German plain hunted for marine fossils before they were found? And is one year's search over hundreds of thousands of square miles to be considered exhaustive? We think not.

Although we cannot accept Professor Agassiz's explanation of the phenomena, we willingly recognise his claim to having advanced our knowledge of Geology by proving these formations to be very recent, and not to belong to the Devonian and Triassic periods. We can also recommend the book to general readers who take any interest in Natural History. It is agreeably written, and contains many of those interesting accounts of little episodes and experiences which go so far towards making the charm peculiar to a good book of Travels.

II.—A PRACTICAL GUIDE FOR TOURISTS, MINERS, AND INVESTORS, AND ALL PERSONS INTERESTED IN THE DEVELOPMENT OF THE GOLD FIELDS OF NOVA SCOTIA. By A. HEATHERINGTON. 12mo. pp. 177. Montreal, 1868. John Lovell.

THIS little work, which as stated by the author, has been brought forward for the express purpose of directing the attention of capitalists to the development of the mineral resources of Nova Scotia, seems to give a fair statement of what is known at present with respect to the gold-fields of that country.

It is got up in a compact and handy form; and, after an introductory sketch of the history of the colony and of the first discoveries of gold, which appear to have been made as far back as 1849, it gives a brief description of the several auriferous districts which have been proclaimed, or in which gold is known to occur.

The Geology is represented by abstracts from the reports of Professors Taylor and Silliman of the United States, and of the Government explorers, Messrs. Poole and Campbell, and is illustrated by a coloured section across the gold-bearing rocks of the Atlantic coast of Nova Scotia, by the last-named explorer. The prevailing rocks appear to be metamorphic and granitic; the strata being divided by him into a superior clay-slate group resting upon an inferior quartzitic formation; and from his section it is seen that all the gold-fields occur immediately on the point where these rocks have been violently disturbed and form anticlinals, from which it may not unreasonably be inferred that the introduction of the gold is in some way connected with the appearance of the eruptive granitic rocks.

Gold has also been found in the alluvium in minor quantities, but the future of Nova Scotian gold-mining is considered to depend entirely upon following down the auriferous quartz lodes in depth; and, as far as yet proved, the promises are encouraging.

The present system of working the mines, crushing and amalgamating the gold quartz, are described, and considerable information calculated to be of service to the adventurer is given, whilst at the end of the work several extensive tabular statements showing the mines in exploration, produce, cost of extraction, etc., are given, which must have cost considerable labour in compiling. The present mining laws of Nova Scotia are given as an appendix.

III.—A SYSTEM OF MINERALOGY. Descriptive Mineralogy, comprising the most recent discoveries. By JAMES D. DANA and GEORGE J. BRUSH. Fifth edition. Rewritten and enlarged, and illustrated with upwards of 600 woodcuts. 8vo. pp. 827. London, Trübner and Co., 1868.

BY the publication of a new edition of his work, Professor Dana has rendered an essential service to the student of mineralogy. This science has made great progress during the long interval which has elapsed since the last edition was published (1854). Chemical researches have been carried forward in connection with almost every species, and analyses have been largely multiplied; crystallographic investigations also have been numerous and important. Moreover, the number of species has been much enlarged, and, in addition, a systematic recognition and description of the *varieties* of species, and the original locality of each is also given. The number of species described is 834, including the Hydro-carbon compounds, and those of uncertain place in the system. To this is appended a supplement containing additional facts and notices (104) of imperfectly known, of recently described, or new species which came to hand too late for insertion in their proper place in the volume. A very useful and important feature of the work is the list of synonyms of each species, arranged in chronological order, with the date of all publications cited, thus rendering this treatise, to some extent, an account of ancient as well as modern minerals. These historical researches evince on the part of the author an amount of labour which few would be willing to undergo, and for which we are deeply indebted to him, although it has delayed the publication of the work about a year.

Nor is this all the industry bestowed upon the work. Professor Dana states that "not a page, and scarcely a paragraph, of the preceding edition remains unaltered, and full five-sixths of the volume have been printed from manuscript copy. Neither the consultation of original authorities, the drawing of conclusions, nor the putting the results on paper have been delegated to another." In this remark the paragraphs on the pyrognostic characters are excepted; for *these*, as well as other assistance in the preparation of the work, the author owes much to the friendly co-operation of Professor G. J. Brush, whose skill in analytical chemistry and thorough knowledge of minerals have enabled him to afford aid and advice, as well as furnish new facts on various points during the progress of the work. The pyrognostic characters have been entirely rewritten by him,—personal trials of the blowpipe and other reactions having been made for the larger part of the species before writing them out.

Mineralogy is a science which, unfortunately for the student, varies considerably in the classification of its objects, according to the views of each writer or curator, whether it be in a descriptive treatise or the arrangement of a museum. Various, indeed, have been the classificatory systems for minerals, from that of Werner, who simply divided them into earths and stones, salts, metals, and combustibles, to those used at present. Nor is the same author always consistent, for during the thirty-one years that have elapsed since the first appearance of his "Mineralogy" (1837), Professor Dana has considerably modified his views of the classification of mineral species, in each successive edition,—from that of a strictly *natural* arrangement in the first edition (1837) to the one at present adopted, in which the general system of classification remains unaltered from that of the fourth edition (1854), showing that he evinces no aversion to change when the progress of science requires it. This system is based on a comprehensive view of the characters of mineral species, the pre-eminence being given to chemical, the next place to crystallographic, the third to the different physical characters. The following are the general subdivisions adopted in the descriptive portion of the work:—

- I. Native Elements.
- II. Sulphids, Tellurids, Selenids, Arsenids, Antimonids, Bismuthids.
- III. Compounds of Chlorine, Bromine, Iodine.
- IV. Fluorine Compounds.
- V. Oxygen Compounds.
  - I. Binary Oxygen Compounds.
    - (1) Oxyds of Elements of Series I.; (2) Of the Arsenic and Sulphur Groups; (3) Of the Carbon-Silicon Group.
  - II. Ternary Oxygen Compounds.
    - 1. Silicates, A. Anhydrous Silicates.
      - (1) Unisilicates; (2) Bisilicates; (3) Subsilicates.
      - B. Hydrous Silicates.
        - (1) Hydrous Silicates Section; (2) Zeolite Section; (3) Margarophyllite Section.
    - 2. Tantalates, Columbates.
    - 3. Phosphates. Arsenates, Antimonates.
    - 4. Borates.
    - 5. Tungstates, Molybdates, Vanadates.
    - 6. Chromates, Sulphates, Tellurates.
    - 7. Carbonates.
    - 8. Oxalates.
- VI. Hydrocarbon Compounds.

It is to be regretted that the author has not given the old and new notation formulæ under each mineral species, in order to meet the requirements of the present transitional state of Chemical science.

The formulæ K_2O and Na_2O (page xvi.) given to *Potash* and *Soda* may be, perhaps, attributed to a slip of the pen, or to the confusion of mind which we have found to be the frequent result of few hours work at comparing old with new formulæ.

In the description of species, the characteristics are mentio in the following order:—1, Crystalline form and structure; hardness, specific gravity, lustre, colour, diaphenity; 3, varie and chemical composition; 4, Pyrognostic and chemical characte 5, Geological position, localities, mineral associates; 6, alte forms; 7, artificial and furnace products.

The introduction, although too brief, contains a useful and planatory section in chemistry, one on crystallography, anothe nomenclature, embodying some very interesting remarks on naming of mineral species, and the want of conformity in the sys of nomenclature. In order to render the work more uniform, fessor Dana has proposed that the names of species should hav far as possible, the termination of *ite*, and has accordingly cha a number of the names in the course of this volume.

This plan, however good in itself, is open to the same objec that applies to the alteration of the established nomenclature in other branch of science, namely, that of creating confusion instea order: for when a name becomes well known and gene adopted, nothing but mischief can result from changing it. termination here proposed, moreover, has no definite meaning that conveyed by the chemical terminations "ite" and "i "Iodite" is changed into "Iodyrite," (p. 117); "Haüyne" "Haüynite," (p. 332); "Nosean" into "Nosite," (p. 3 "Leucophane" into "Leucophanite," (p. 260); Common Sal changed into "Halite," (p. 112); and "Blende" into "Sphaler (p. 48). No mineralogist, during the last twenty-five years, ever thought of applying the name "Blende" to anything but phide of zinc, and we cannot, therefore, think this a good alterat The name "Pitch-blende," very properly abolished, is replaced "Uraninite" (p. 154), but the name selected as a substitute is un tunate, for it is sure to be confounded with "Uranite," a w known name for "Torbernite," a very different mineral. " oxene" is retained instead of "Augite," (p. 212); the latter n being considered as only entitled to be used for *one* of its varietie "Sal-ammoniac," (p. 114) a bad name, is retained; wher according to Dr. Dana's rule, it ought to have been changed some more definite mineralogical term; "Salmiac" has long its mineralogical name. We must also protest against the n "Niccolite," (page 60). The derivation of names from "dog-Lat is excusable from no point of view that we can find.

We could multiply these cases considerably, but what we anxious to point out is, that such changes as we have referred always objectionable, become more so when apparently app capriciously, and especially in cases where no rule can be gener adopted.

A far more objectionable change to English chemists and mine ogists, is that of oxide, sulphide, fluoride, etc., into oxid, sulp and fluorid. Ready as we are to express our thanks to Dr. Dana his teachings in mineralogy, we must enter our protest against the introduction of a termination disallowed by all European chemists.

A valuable bibliography completes the Introduction, containing the titles of about 300 works, memoirs, and papers, which are referred to in the following pages.

In congratulating our readers on the appearance of this standard work of reference, which has been posted up, as far as was possible, to the date of publication, we cannot but again notice the untiring energy and zeal of the veteran author, who, amidst his laborious task, has not failed fully to acknowledge the assistance and obligations he is under to the various men of science during the preparation of this work.

IV.—AN ESSAY ON THE GEOLOGY OF CUMBERLAND AND WESTMORELAND. By HENRY ALLEYNE NICHOLSON, D.Sc., M.B., F.G.S. 8vo. pp. 93. 1868. London: Robert Hardwicke.

THE author, in a short preface, tells us the origin and scope of the Essay which he has now given to the world. It is an Edinburgh University Prize Essay of 1867, with additions and corrections. It proposes to give a sketch of the Geology of the Lake District, both from the author's own observations, and from the works of previous writers, whose statements the author has in most cases verified. The work is carefully done, and the essay forms a manual which should be in the hands of every one interested in the structure of the Lake Country, and indeed of every student of Silurian Geology.

In the introduction, the author describes the general structure of the district, and enumerates the formations which occur within it, pointing out their equivalents in other parts of the country. Here some of his general conclusions as to the absence of certain groups depend upon this identification, which, in the more detailed description which follows his introduction, it will be seen is not unquestioned.

The Lake District seems to have formed an island, during the earlier part at least of many great submergences. Our author says (p. 6), "Near the close of the Devonian Epoch the land again commenced to sink beneath the sea. The subsidence, however, was not sufficient to submerge the more elevated portions of the Silurian area." And further on (p. 8), he speaks of "a steady depression of the sea-bottom, which lasted till the close of the Permian Epoch, without ever attaining to any great intensity, since most of the Permian strata show signs of having been deposited in seas of no great depth." And again, (p. 9)—"During the Glacial Epoch, the central and higher portions of the Lake District appear to have escaped submergence."

This may be so; but when we remember the enormous thickness of the Carboniferous deposits in Lancashire, and see that the lower beds only of the series abut against the mountains of the north, we ask what prevented the flow of the *later* Carboniferous sea over the Lake Mountains: if they were then anything like what they are now, and similarly in the case of the Permian, we must have some explanation why a deposit, estimated at 8000 feet, in a valley bounded by hills between 2000 and 3000 feet only, should not have extended over those hills, unless the Lake Mountains were at least 5000 feet higher *relatively to the present base of the Permian*. Moreover, if the Carboniferous deposits never extended over the Lake Mountains, the Permian conglomerates should contain more Silurian fragments.

On the whole, the evidence rather goes to show that the Carboniferous deposits did extend over the Lake District, and the Permian was only prevented from resting on the Silurian Rocks also, because the Carboniferous intervened. We have, however, the fact that in the north-west of England, there was from a very early period an irregular boss of old rocks which affected original deposition and subsequent denudation.

It does not seem clear why the author objects to "the theory that the older rocks of the Lake District have been raised along an axis of elevation running across the district in an E.N.E. and W.S.W. direction," (p. 2). This is only another way of saying that the older rocks come up along a line running in the direction named, and that the newer rocks crop out in order on the north and south of it. Surely this is a fact (see pp. 20 and 21); and moreover, one which does not involve any theory as to the direction of the faults, and does not imply that there are not many folds parallel to the principal line of upheaval. There is certainly more than a "*single* line of elevation," and the group of mountains can only be called a dome-shaped mass in reference to the general surface-configuration.

The evidence on which he grounds his view that the Silurian high ground extended from the Lake District to the Isle of Man, in Carboniferous times, does not seem quite satisfactory, for the denudation that could have removed that quantity of Silurian rock between the Carboniferous and Permian times could have removed the same quantity of Carboniferous strata in the same time or less. It seems more probable that this great denudation was principally effected in the vast unrepresented time between the close of the Silurian and the commencement of the Old Red Conglomerate age.

The question of the faults of the Lake Country is one of great interest. The author has pointed out the direction and circumstances of the principal ones, and says that they may be classified in two great systems according to their direction and age. Faults from the nature of the case are difficult lines to draw, except where rocks of a different character are thrown together. As the author has pointed out at the end of his introduction, the smashed rock was a line of weakness along which rivers, glaciers, and all denuding agents have worked. Hence great faults generally coincide with valleys, and are covered up by drift and alluvium. The author has, perhaps, generalized too far with the data in his possession. For instance, the Craven and Penine faults are not each of them one great fault, but a set of nearly parallel faults of various age, the downthrow of some being on one side, of others on the other. One of the Craven faults is evidently pre-Carboniferous. The Lune-valley faults are a great set (there are, at least, four seen in section) connecting the Craven and Penine faults, and as those are of various downthrow and age, so these connecting faults, though by direction to be referred to the N. and S. system, are, in all probability, of various downthrow and age. In all these great sets of faults it will be found the rule, and not "a rare phenomenon, to have the upthrow side . . . . . not entirely removed by subsequent denudation" (see p. 12).

The author then proceeds to describe in greater detail the various formations, commencing with the lowest, the Skiddaw Slates. Prof. Harkness and Dr. Nicholson have given much time to the working out of this set of rocks, and, from their fossils, refer them to the Llandeilo series. They consist of slates and shales, with harder, more gritty beds here and there. There are few fossils, but Graptolites. Dr. Nicholson has, however, paid particular attention to those organisms, and is the author of several valuable papers on the subject. The Skiddaw Slates can be traced through the Isle of Man, and seem to be represented, in part, in North Wales by the Arenig group.

He expresses a doubt as to whether the Green Slates and Porphyry are conformable on the Skiddaw Slates. Certainly the very marked and sudden change in lithological character from soft slates to hard felspathic schists, grits, etc., would suggest a break of some kind, and the occurrence of fragments like Skiddaw Slate in the overlying breccias confirm this, as they show that the beds from which they were derived were hardened, upheaved, and denuded before the formation of the breccias; but the identification of a piece of slate must be very doubtful, and therefore we may say that we have yet no data sufficient for the determination of this point. The uniform character of the Skiddaw Slates over a very large area shows that this is no mere local change, due to shifting currents, but must be referred to some of those wide-spread changes which influenced the great differences in successive geological formations and the life of the period. Our author describes the Green Slates and Porphyry as a vast series of bedded greenish-grey felspathic ashes or breccia with interbedded porphyries, and states that characteristic Bala fossils occur in flaggy shales or hard grits near the top. It may be open to question whether these fossiliferous bands should be bracketed with the Green Slate series or with the overlying Bala Limestone group. The district under the Penine range, in which they seem to to occur lower down in the series, as described by Prof. Harkness, is so tremendously faulted and masked by drift, that it is not safe to infer that the section is complete between the points where only these fossil bands have been found. For the solution of this question also we must wait for further evidence.

It has often been objected to some of our older terms, such as greywacke, schist, etc., that they are too indefinite. Perhaps it is a greater mistake to use terms too strictly defined in investigating imperfectly understood formations. Such terms as Porphyry and Ash-beds often imply too much. Some general term for rocks of a porphyritic structure, without reference to their mineral composition, and for those ash-like beds which graduate into a breccia on the one hand, or gritty sandstones, etc., on the other, without involving any theory as to their origin, would be safer and very useful as enabling a field geologist to state what he actually saw and no more.

There are two points of view from which we may approach the study of the Igneous and Metamorphic rocks,—1st. Their stratigraphical relations, *i.e.* their behaviour as rock-masses, their lie with relation to the strike of the beds among which they occur, their variation in general structure, and the alteration of the neighbouring rocks; and 2ndly. Their mineral and chemical composition.

Our author has chiefly confined himself to the former and remarks (p. 46) that all the various granite-masses of Cumberland and Westmoreland are strictly confined to the Green Slates and Porphyries. Then, pointing out that this series consists almost entirely of felspathic ashes and breccias, with interbedded porphyries, suggests that the fact that the granite occurs always among rocks which themselves show evidence of volcanic activity during the period of their deposition, may throw some light upon the origin of granite. From what follows we see that he implies that the igneous action which caused the volcanic outbursts, to which he refers the ash-beds and porphyries, caused later on in the same area the intrusion of granitic masses.

Mr. Marshall in an able paper read before the British Association (1858, p. 84) has propounded another view. He holds that there was a given (not a necessarily uniform) depth at which the internal heat of the earth was sufficient to alter or even fuse rocks of a certain mineral character; that in the unequal depressions to which the rocks of the Lake Country were subjected, owing to the crumpling up of the beds, various parts of the series were carried below that horizon and altered more or less accordingly; that the granite represents the extreme of this metamorphism.

Dr. Nicholson points out the passage from the granite into the felspathic beds in which it occurs, and speaks of the alteration of that part of the granite which is in contact with the sedimentary rocks. By this, we suppose, he means that the more sudden rate of cooling of the outside of the mass, owing to the lower temperature of the sedimentary rocks with which it was brought in contact, has caused the granite to crystallise there in a rather different manner. Obviously this fact of the passage from the granite to the sedimentary rock is as easily explained on Mr. Marshall's view.

One point seems often to come out from a careful examination of a granitic mass. The granite seems to *replace* a certain portion of the sedimentary strata, and not to *displace* them, leaving them pushed out on all sides. If we suppose the intruded rock to eat its way into the sedimentary strata, assimilating portions of it, we allow a good deal of what is asked by those who hold the metamorphic origin of granitic rocks, *i,e.*, the possibility of changing a sedimentary into a granitoid rock. The advocates of that theory may take their stand upon the assimilated portion, and ask is it the heat of the intruded mass, or the new conditions under which the minerals have been brought into contact with the sedimentary rock, which has produced the change, and then point out that both the one and the other may be obtained by a sufficient depression of the sedimentary rocks.

The author next describes the Coniston Limestone, which consists of dark greyish blue slates and shales, with bands and beds of impure limestone of varying thickness and irregular occurrence. It apparently overlies the Green Slates and Porphyry conformably, with beds of rather an intermediate character between; but as the passage beds consist in a great measure of soft slates, the junction is mostly obscured. This formation is universally allowed to be the equivalent of the Bala Limestone.

There is considerable difference of opinion, however, as to where we should draw the line between these Bala beds and the overlying Coniston Flags and Grits. Professor Sedgwick published, as the result of his original field work, the view that the Flags and Grits were the commencement of an entirely different group, and if we look at Prof. Ramsay's Geological map of England and Wales, we shall see how naturally the sweep of the Denbighshire Flags and Grits resting, as first shown by Professor Sedgwick, unconformably upon the Bala beds in North Wales, would, if prolonged, include the mass of Coniston Flags and Grits in the Lake District; while the general character of the Flags and Grits is so similar in both cases that there is much to suggest that the Coniston Flags and Grits bear the same relation to the Coniston Limestone that the Denbighshire Flags and Grits do to the Bala Limestone. Prof. Harkness and Dr. Nicholson include the Flags and Grits with the Coniston Limestone in the Lower Silurian, and consider them as higher beds of the Lower Silurian series than any exposed in Wales. One of the officers of the Geological Survey, wishing to have the question discussed by those acquainted with the district, has, with the permission of the Director of the Survey, anticipated their official publications to point out in a paper in this Magazine, that the result of his mapping as far as it went, tended to show that the original classification of Professor Sedgwick was right. (GEOL. MAG., 1867, Vol IV., p. 346.)

This makes a difference of, at least, 6,000 feet in the position of the base of the Upper Silurian rocks. It will appear, at once, from the statement of the points at issue, by Dr. Nicholson, that we require more evidence as to the stratigraphical relations of the beds at the base of the flags before we can consider the question settled. It seems most improbable that the fossils in the two lists, given on p. 62, can have come from the same beds.

The Coniston Grits pass up very gradually into slaty and flaggy beds, to a part of which the name Bannisdale Slate has been given; and, although they are, undoubtedly, only part of the Coniston Grit series, they form a division as useful and as marked as the Flags into which the Coniston Grits pass down. Our author, having shown that in some cases what were supposed to be flaggy beds above the Coniston Grit, are, in reality, only the Coniston Flags, repeated by faults or folds, drops the Bannisdale Slates altogether; but there is no doubt that we have certain flaggy beds at the top of the Gri with few fossils (Orthoceratites, Graptolites, etc.), the relation which to the lowest fossil-bearing Ludlow rocks has yet to be sati factorily made out.

The author having noticed the two divisions of the Ludlow Rock proceeds to point out that the highest Silurian Rocks seen in t Lake Country are the Flaggy Grits of Benson Knot and Kirkl Lonsdale. Above these there is an enormous break, perhaps t greatest of which we have stratigraphical evidence in the wh geological series. The Silurian rocks were crumpled up, cleav heaved up into dry land, valleys were scooped out, and then the (Red Conglomerate washed into those valleys; hence it is now fou only in patches and pockets. Clearly this has nothing to do w the red shales and sandstones which elsewhere succeed the Ludl rocks conformably. As the Carboniferous sea crept on, these co glomerates were overlain by other beds, either partly derived fr the same source as the conglomerates, or perhaps, partly compo of those conglomerates re-sorted. In these plant-remains have be found by Dr. Nicholson. It would, perhaps, be better not to c these top beds Old Red Sandstone. They are evidently a kind *Basement Bed* to the Carboniferous Limestone, and should the mas of conglomerate turn out to be subaerial, it will be found to h complicated the question to have assumed that these plant-beari beds are part and parcel of the irregularly disposed conglomerate

Our author then gives a short *résumé* of what has been done in Carboniferous series, and passes on to a more detailed examinati of the Permian Rocks. The classification adopted is that of P fessor Harkness, whose views on the Geology of the Lake Coun generally, we may gather, agree on all important points with th expressed in this Essay.

The Permian Rocks are divided into three parts. The Low Permian consists of a great but irregular mass of breccia or co glomerate, succeeded by light red sandstones, and these again other breccias of a rather different character from those below.

The Middle Permian consists of thin-bedded sandstones of vario colours and marly shales with plants, succeeded by impure magnesi limestones and sandstones, above which come a set of red laminat clays.

The plants of the Middle Permian are very interestin "Though tolerably plentiful individually, they belong to few gen and species, and they have a decided Permian facies, being speci cally distinct from any true Coal-plants. It is worthy of rema that the Coniferæ now first produce true cones, thus differing fr the 'taxoid,' or berry-bearing forms of the Carboniferous Epoch p. 87.

The Upper Permian consists of dark red fine-grained sandston separated by courses of red shale. These beds were shown by Roderick Murchison and Professor Harkness to succeed the Mid Permian conformably and to pass into them, and on this grou they are grouped with the Permian rather than with the Tri

This was a difficult point to work out, as the evidence of their position is not very clear, and their lithological character not very different from the nearest Trias beds.

It is a remarkable fact that the Limestone conglomerate of St. Bees is said to be the equivalent, not of the breccia or conglomerate which forms the base of the Permian near Penrith, but of that which comes at the top of the Lower Permian. If this is due to the gradual and unequal submergence of the land, the St. Bees area being the latest down, we ought, if we could trace the deposits of the receding shore, to find the lower breccia creeping up in patches to join the higher at the expense of the intermediate finer formation.

The author concludes with a notice of the occurrence of Trias and Lias in the north of Cumberland.

On the whole the essay, with its full lists of fossils and descriptions of many new forms, is a very valuable contribution to geology; but the author describes a large and varied district, where many phenomena difficult of explanation occur, and in which, from its peculiar insular conditions at successive periods, many of the formations have peculiar characters. It is a country in which the relation of the beds to one another and to similar beds elsewhere can only be made out by very detailed mapping, sections drawn to true scale, and a careful determination of the exact horizon from which fossils are obtained—a task sufficient to employ a large number of observers a very long time.

REPORTS AND PROCEEDINGS.

ADDRESS TO THE GEOLOGICAL SECTION OF THE BRITISH ASSOCIATION, Norwich, August 19, 1868.

By ROBERT A. C. GODWIN-AUSTEN, B.A., F.R.S., etc., President.

THE basin of the North Sea, in the physical changes which it has undergone since the commencement of the Kainozoic period, is an area which well repays the study of the geologist. Suffolk and Norfolk, which geologically, as they do ethnologically, form one region, are part of the slope of this basin on its western side; for the North-Sea valley is a true physical depression; the whole Secondary series of strata, on one side, dips eastwardly towards it, and rises again above the sea-level, on the opposite side, in Denmark. It is a depresssion which dates back its origin to some distant time in geological history.

It is to this area that I propose to restrict myself in those observations, which, in compliance with established custom, I have to make in opening the meetings of this Section.

The North-Sea depression, in its *hydrographical* features, deserves a passing notice. Compared with its breadth, its depth at present is exceedingly small. There are central portions where there are only twelve feet of water. The "Deep-water Channel" of the charts, which runs parallel with the coasts of Essex, Suffolk, a Norfolk, has a maximum depth of only 180 feet. A change to th amount of depression of sea-level would lay bare the whole of th sea-bed from the coast of Northumberland across to Jutland. depression of only 120 feet would produce nearly a like result; th new coast-line would in this case run from Flamborough Head Heligoland and Holstein. There would be an extension of the gr Germanic plain nearly to our area. The "Deep-water Channe alluded to would in either case become the course of the Thames a its tributaries, till it found its way seawards to the west of the Gr Banks. To such an extent would this small amount of change water-level alter the whole physical character of Eastern Europ and yet this change would be insignificant, compared with th which this very area has repeatedly experienced. There is one ot feature presented by the North Sea basin. A deep submarine trou has been traced at a mean distance of about fifty miles from coast line of Norway; it commences in the meridian of Christia and, conforming to the outline of the land, goes north beyond N. 60 deg. South of the Naze of Norway, there are soundings of u wards of 200 fathoms; beyond they are less, but whether decrease is progressive is not clear. *Across* the line of great depth the change is abrupt. This curious feature in the outline the sea-bed is just what would have been produced by the s sidence of the whole of the southern portion of the Scandinav region, together with fifty miles of area around, to a depth of 600 700 feet. There are good grounds for supposing that such has b the process: and the geological history of the basin seems to sup the precise date of the subsidence in question.

As a point in physical geography, it was the depression of Scandinavian mass along the line indicated which produced channels of the Skagerrach and the Cattegat, and opened a co munication from the North Sea into the Baltic depression.

Geologically, some of the later stages or periods of the earth's p history are so abundantly illustrated over the East-Anglian area is a field in which there have been so many labourers, as to whi too, there yet remain so many unsolved points, that I cannot h hoping that this Section will follow to some extent the example by their brethren the geologists of France, at their annual *réuni extraordinaires*, and make local geology a prominent subject of th deliberations at this meeting.

The points of interest alluded to belong to the great Kainoz period; indeed it is in this portion of England alone that the co plete sequence of change, as it happened in this country, can followed out; and as the term Kainozoic is what alone I propose employ, I would explain that it is a Greek compound, signifyi "recent living," or indicative of that general period of which t fauna, in some proportion, is specifically identical as to forms, w such as are now known to be living in some region or other.

Geological Summary.—Wonderful as the progress of research l been during the last fifty years, still the geologist finds hims greatly wanting, when he attempts to sketch out, in consecutive order, the history of any district, however limited and however simple it may be. He may know that the Nummulitic period was subsequent to the Cretaceous, and also that everywhere an interval of time has separated them; but he does not know, nor has he any means of ascertaining, how long that interval was; and though he may know all the details of the successive conditions of the thick series of depositions exhibited in the London basin, and have satisfied himself of the great extension they must once have had beyond their present area, yet of the process by which so much has been removed he does not know anything, nor of what was being done in any other region of the globe when so much was being undone here. All that can be said is, that here, in the south and east of England, the Nummulitic strata were cut back to a line along which are now Sudbury, Ipswich, and Yarmouth, and that beyond, on the west and north, stretched away the bare Chalk hills of Suffolk and Norfolk, northwards still, into the wolds of Lincoln and York.

For our present outline we need not go further back than this in East-Anglian Geology; at the time of the early marine formations of Kainozoic age, the British-Islands group was united, as a whole, with a broad European-continental region.

The Kainozoic formations of Western Europe have a striking uniformity in their general history; those of Spain and Portugal—next, those of the Bordeaux basin and of Touraine, with its Breton dependency—finally that of our North-Sea basin, were all indents from the great Atlantic; and, in all, the character of the fauna is Atlantic. It is also noteworthy that in each of these southern and now dessicated sea-basins the fauna is more southern than that now living in the adjacent seas, that the fossil mollusca of the Tagus beds present Senegambian relationships, that so, too, do those of the Lower Bordeaux beds. The Upper Bordeaux beds are southern and Lusitanian in their fauna, as are those of Touraine and Brittany, and partly so the older Crag of Suffolk, Belgium, and Germany. The southern relations of these several assemblages grow weaker from south to north, whilst in the North-Sea basin distribution from another quarter shows itself, in the presence of its many Transatlantic forms. In this there is evidence of a twofold change—First, a set or extension northwards of a marine fauna which in its recognised forms is West African, afterwards becoming less southern over the same areas; such was the zoological change which the lapse of time brought with it. Next, the areas of these formations are first presented as terrestrial surfaces, then as lateral branches of the Atlantic, lastly as laid bare again; and this process seems to have proceeded from south northwards. The comparison of the whole of the fauna of the Tagus beds with the whole of that of the Bordeaux basin suggests that the first had been wholly laid dry before the other; so likewise between the Bordeaux basin and that of the Loire.

The Crag-sea waters were expelled from the North-Sea area by the rise of the land on the south of that great bay. The most southern points for the Crag beds in Belgium are now the highest above the sea-level; this elevation decreases till we come to this place, where, if any part of the so-called Norwich Crag or the Fluvio-marine be of that age, such estuary beds must have been then much in the same position as they are now, or at the sea-level. On evidence such as this, the North-Sea area, after the period of the early Kainozoic fauna or true Crag, is seen to be passing again to the condition of terrestrial surface.

This old depression of the North-Sea area, as had the other Tertiary basins, again became part of the general European land-surface—a northern extension of the Rhine valley; and again the geologist meets with but little guidance as to the details of the chronology of what must have been a period of vast duration. A long list of land animals can be presented which have left their remains here: that some of these ranged over Central and Southern Europe, and included this very district in the area of their life-period is undoubted; but as to how many of these co-existed, or to what extent they indicate a successive occupation, is still an undecided question.

The "Forest-bed" of Cromer gives a glimpse of what was the vegetation of this period; but here, again, it is more than probable that it must be taken only as the facies of the flora of the last stage of terrestrial conditions antecedent to the next great physical change, rather than that of the whole period.

The whole mammalian fauna, from the Norfolk Mastodon to the Mammoth (*Elephas primigenius*), seems to offer itself as an assemblage of the members of nomad tribes, which have yet to be reduced to order of time. The general condition of Northern Europe was terrestial for the whole of the Tertiary or Kainozoic period; during that time its conditions as to climate passed from warm to temperate and to arctic. To its close belongs the evidence everywhere recurring, and at every level, of its subaërial glaciation and greater elevation.

Just as the Crag and Falun beds come in here, on our East-Anglian district, and on the Continent, as breaks in the lapse of Tertiary terrestrial conditions, so the accumulations of the great northern submergence come in as a second intercalation, only that the physical change in this case was greater and of a different order. The Arctic basin extended itself as low as to N. lat. 50 deg. by a slow process of submergence from north to south.

Again the northern hemisphere emerged, apparently, in a contrary direction, or from south northwards; again the agencies of ice and snow and excessive rainfall are exhibited, till again, for its general arrangement of land and sea, this immediate district and England generally is presented with the like relations as it had at the period of the Crag-sea.

The general character and the order of change of the Kainozoic period admits of being thus briefly told; but when it is attempted to follow it out in its details, it is found to be a long and complicated record.

Over the whole of the European area, as yet less accurately traced across the Asiatic, very distinct upon the American continent, there s a region which presents broad expanses of waterworn detritus, ands, and loams, often placed at considerable elevations above preent water-levels, which, from their superficial extent, has caused hem to be identified with the component members of another derital group (the Glacial Drift) peculiar to another area, from which hey are distinct as to conditions and mode of accumulation. The onditions indicated are those of low winter temperatures, terrestrial urfaces with a configuration such as the same countries have at resent, alluvial and fluviatile accumulations, indicative of torrential and periodic rivers.

A line drawn across the European area, occasionally on one side or ther of that of north lat. 51 deg., defines the north limit of all this lass of detrital accumulations of the Kainozoic period; on the south f this all these accumulations have their limits, and the sources of heir materials are within the areas to which belong the existing iver-systems of the South and Mid-European continent.

North of this line the detrital accumulations are neither local as to omposition, nor have they much reference to surface configuration, lthough such configuration pre-existed. Over this area, too, are the ndications of low temperatures and broad alluvia. The distribution f the detritus over this area shows that the expanse of water was ontinuous, and was marine. Over one area are the results of a general and uniform submergence; over the other the phenomena re local and alluvial.

Over the British and part of the European area there is a good break in Kainozoic time into Præglacial and Postglacial; by the erm "Glacial" being signified the period of the great extension of he Arctic basin.

This Drift-formation, in one form or another, covers the whole surface of this county, from the sea-level up to the summits of the Chalk hills. We have, in Norfolk, evidence of submergence to the extent of 600 feet and upwards. There are other parts of this island where the submergence exceeded this, even in this latitude; so that here the highest land may not be a measure of the greatest amount of submergence. It was a time when the whole of the British-Islands group became submerged, with the exception of a few salient points; and, taking the levels to be derived from these points, together with the general character of the phenomena, we may accept as certain that subaërial glaciation, in all its varied modes of action, had long been at work here prior to that submergence. The change of relative level was not sudden; it proceeded from north southwards; and it is in the north that the amount of the submergence was the greatest.

The Drift of Norfolk has good illustrations of these several sets of conditions, and of the manner in which the phenomena of one period have been modified by conditions which followed. It has been well said that in geological history time is of no object; but in a geological address, such as this, it has its claims; so that instead of dwelling at any length on the general condition of the British Islands at the time of their greatest submergence, I have represented on a map of the northern hemisphere the whole of the area which became submerged (B), and, for the purpose of comparison, there is along with it another, showing the extent of the present Arctic basin (map A).

The Drift-accumulations of this county are exceptional in this one respect, that they attain unusual thicknesses. The Cromer cliff, which is wholly of this formation, is 270 feet in height: this is not so much an indication of the lapse of time during the submergence, as the result of position. Situated on the eastern slope of the English central area, towards the North-Sea depression, during the first or subaerial stage, the form and slope of the land would favour the transfer of materials downwards and outwards: in the subsequent stages, the areas of greater depth would receive the greatest amounts of the abraded spoil of the land-areas encroached upon. So likewise during the period of emergence, the transfer of material would be outwards. The most reasonable explanation of the present shallow condition of the North Sea, as compared with its depths when occupied by the Crag sea, is, that it has been filled by the aggregate of the accumulations of the Drift-period.

The former extent of the Scandinavian region is of interest to the British geologist during several periods—during the Glacial period, from the spoil that was drifted from it and scattered over our eastern counties.

From early times this region was in the condition of dry land. No beds of the age of the Crag have been met with on its surface; the absence of this formation, which occurs on the coast of Denmark, suggests that the land of Norway then stood at a higher relative level. That this was so is indicated by the manner and extent to which the surface is scored by glacial action, not only down to the present sea-level, but far below it. The deep fiords were occupied by glaciers; they passed over the numerous islands off that coast, which, too, are all scored.

The submarine trough which contours Norway must have been produced subsequently to this greater elevation of the region. The Crag-sea coincided with part of that period of elevation; and its marginal beds in that quarter lay some fifty miles or more from the Norwegian coast-line. The subsequent depression amounted to more than the depth of the trough, inasmuch as around the upper end of the Gulf of Christiania, there occur marine beds at elevations of 500 feet above the sea, indicating a total change of level of at least 1200 feet.

Whatever the amount of this former elevation of the Scandinavian land and the precise period of its glaciation may have been, the geological phenomena about Christiania, so carefully described by the naturalist, M. Sars, show clearly that the whole has also been much below its present level. The phenomena, as a whole, correspond with what took place over our area, but they are so much more definite that they deserve brief notice as part of the physical history of the North-Sea basin. From an elevation of 500 feet down to 300 feet there is a succession of marginal sea-lines, with banks of littoral and sub-littoral shells (Skjælbanker). These have also their deeper water-beds and shells (Mergelleret). These successive lines show that the rise of the land through the 200 feet in question was at intervals.

The marine fauna of this higher sea level is given first in its littoral, and next in its deeper-water facies. Taken together, we have this result—that all the species are now living, that it is an Arctic-basin assemblage, and not at all that of the neighbouring seas. This is the "Glacial formation" series.

Below the 300-feet level there occurs a belt or interval 150 feet broad, over which "shell-banks" are not met with, below which a second series occurs. The shells contained in these beds differ from those of the higher series in being less arctic. Certain of these characteristic forms have disappeared, numerous boreal shells have made their appearance, together with forms of the Lusitanian region. Altogether this marine fauna approximates to that of the neighbouring seas, only that some members of the earlier or more arctic series linger on.

The subdivision of the East-Anglian Kainozoic series is as follows:—

A. Præglacial; B. Glacial; C. Postglacial.

A. *Præglacial.—Crag,* in Suffolk, is a local agricultural name for any sandy, gravelly soil; but the early geologists and shell-collectors soon found that it was something more; its very perfect shells were recognised as in part agreeing with those of the neighbouring seas, in part as unknown or foreign. Mr. S. Woodward, in his 'Outline of the Geology of Norfolk,' 1833, has a detailed account of this formation. His own views are admirable; the range of the Crag formation, as he gives it, from Cromer, by Norwich, to the Suffolk coast is nearly exact. Nor did the estuarine character of the formation about Norwich escape him. Apart from this local condition, he considered the Norfolk and Suffolk beds to be "decidedly contemporaneous."

It was not till 1835 that a subdivision of the Crag was proposed by Mr. Charlesworth; and it was amended (in 1838) by the following classification:—

4. Upper Crag of Norfolk and Suffolk—
    - *a.* Without mammalian remains.
    - *b.* Beds with mammalian remains.
5. Red Crag. 150-200 species of marine shells.
6. Coralline Crag. 300-400 species of marine shells.

Thus far back Mr. Charlesworth separated the Norwich Crag from that of Suffolk. The Red Crag at Tattingstone, Ramsholt, and Sudbourne was said to overlie a worn and uneven surface of the white or Coralline; from this consideration their relative dates or ages was inferred. This nominal subdivision may be said to have been adopted from that time onwards down nearly to the present.

The Bryozoan Crag overlies London clay, and is under 20 feet thick. It is a good division, because it is an indication of a definite range of depths, where the sea-bed was not within reach of surface disturbance, yet where the drifting power was considerable, and [illegible] of which the [illegible] The [illegible] of sea-bed [illegible] where they are now about [illegible] feet above the [illegible] in the depths of the [illegible] that can be [illegible] as that of their original [illegible] with their present position. It is the lowest [illegible] English area [illegible] any [illegible] where the lowest beds [illegible] the deep-sea deposits of ooze [illegible] depth.

The Red Crag, though a good division for the time when it w proposed, is a complex assemblage, in spite of its small verti dimensions. Of all that was originally so grouped, a very sm portion, only that of one locality, can now be referred to as su namely, the Crag at Walton Naze: in this alone is to be fou an old sea-bed, a marine-life zone, undisturbed since its origi accumulation.

The Red-Crag beds of the valleys of the Stour, Orwell, and Debe though referable to some part of the same general period, are whol rearranged or remainié beds and of the later stages of the Crag-se they are, relatively to the Walton beds, very shallow-water accum lations, presenting that diagonal mode of deposit, known as fals bedding, indicative of surface disturbance and tidal movemen Above them, in places, and on the land side of them, are cert thick accumulations of red coarse sands, which have also been r ferred to the Red Crag, and which at one time I supposed to repr sent a more marginal sea-zone, the ordinary Red Crag being th condition of sea-bed known as dead-shell sand and gravel.

The shell-gravel of Antwerp corresponds with the Red Crag Suffolk. Additions were subsequently made, as in the case of t Chillesford Crag of Prestwich, and the Bridlington Crag.

With respect to the recognition of the fossil shells of the Cr and the use made of such guides, M. Deshayes, in 1831, propos (Ann. des Sc. Nat.) three zoological groups for the whole of t marine series of formations above the Chalk. Of these, the olde or Nummulitic, contains a marine fauna which is wholly extin The middle is what may now be termed older Kainozoic; and it w in his upper or modern group, which included the sub-Apennine a other continental sea-beds, that the whole of the English Crag w included, as comprising a large proportion of living forms.

The Norwich, or Fluvio-marine Crag, the uppermost of Mr. Charle worth's classification, was for many years the subject of differenc of opinion, as to its value and distinctness as a division; it had al gradually been made to include much more than at first: any b containing either Mammalian and Molluscan remains, or even a admixture of fresh- and salt-water mollusca, in any part of Suffo and Norfolk, had come to be put down as the equivalent of t Norwich Crag.

General opinion seems now to have come round to the vie which some geologists had long since taken. Writing in 1865, M

Searles Wood states, "the Norwich Crag is not geologically distinct from the Red, but a fluvio-marine condition of the same period." He establishes this in an analysis of the molluscan fauna, such as leaves little doubt as to this point; and the only criticism which is suggested is—may it not have been an equivalent of the whole Crag period? and may not the Yar valley have been a tributary to the Crag Sea, during its whole duration as such?

In Suffolk, the fluvio-marine accumulations at Thorpe, near Aldborough, Wangford, and Bulchamp, are considered by Mr. S. Wood to be of the same age as that of Norwich.

The Forest-bed of Cromer (1824), and some other places, to which Mr. R. C. Taylor first called attention, and to which he assigned its true age and position, is one of the most interesting points in Norfolk geology; it is the unmistakeable indication of a terrestrial surface, antecedent to the period of the "Glacial Drift" accumulations. This old land-surface, at Cromer, is exposed at the sea-level; but it extends inland, and has been met with at considerable depths in the offing.

The arboreal vegetation buried in these beds comprises the Norway spruce, Scotch fir, yew, oak, alder,—all of them common North-European trees.

What the Cromer coast-section demonstrates is, that by process of change of level a forestial condition of the surface had been brought down to the sea-margin, that the trees had died, and that mud-deposits had formed, partly under fresh, partly under brackish water lagoons.

Subjacent to the "Forest-bed," and covering the surface of the Chalk, is a layer of chalk-flints; a like accumulation is seen resting on the Chalk in numerous other places, as in the sections below this city (Holy Cross, Thorpe, &c.), and are all referable to the same agency and period. The Chalk has been dissolved away by the action of rain-water, and the flints left *in situ;* they indicate a long period of subaërial conditions, and their formation is co-extensive with the whole duration of those conditions; they are therefore of the same period as the "Forest-bed." All collectors and observers seem now to be agreed upon this, that the Cromer mammalian remains are referable to this particular surface.

B. Glacial.—More recently the Norwich sections have been subjected to a closer examination; and according to Mr. J. E. Taylor (1867) these admit of a twofold division: the upper is a coarse and rubbly accumulation, with well-rounded pebbles of flint; the lower consists of finer sands. A band of white cross-bedded sand intervenes. Such a change in the character of successive beds would not, by itself, have been of much importance; but zoologically the differences they present are much more significant.

The fresh and brackish-water forms, which long since gave the Norwich Crag its fluvio-marine character, occur only in the lower division; in this, too, the proportion of littoral species of marine shells is greater; and here also are found all those forms which are supposed to be extinct.

The upper division has its peculiar forms, such as *Modiola modiolus*, *Astarte compressa*, *A. sulcata*, *A. elliptica*. Other shells are now abundant which in the lower are scarce; here they occur as if in their "life-zone," instead of as single valves, worn and broken—such as *Tellina obliqua*, *Astarte borealis*, *Venus fasciata*, *Cardium Gœrnlandicum*, *Cyprina Islandica*, *Rhynchonella psittacea*.

It is only in respect of one shell (*Tellina obliqua*) that the forms of the upper division have not been recognized as living; and with respect to distribution, the northern facies of the upper assemblage is more strongly marked than that of the lower; lastly, they indicate a somewhat greater depth of water.

Mr. S. Wood, jun., admits this division; "the upper bed at Norwich," he says, "is the Chillesford shell-bed."

Chillesford Crag.—In 1849, Mr. Prestwich made known some marine beds in the parishes of Iken and Chillesford, either yellow sands or laminated micaceous clays. At Iken these beds are superposed upon a worn surface of the older or Bryozoan Crag. There is no such direct evidence as to their relation to the Red Crag; bu there is no doubt that they are uncomformable to both divisions.

These beds are in striking contrast to the true Crag, in respect o their composition and the condition of the shells they contain; the were tranquil depositions, the bivalves at every place constantl exhibiting the two shells in contact, and in the positions in whic the animals had lived. With respect to this fauna, 23 species onl were met with—4 Gasteropods and 19 Acephala. Mr. S. Woo recognized the Arctic character of the assemblage, and considere the beds posterior to the Red Crag probably the equivalents of th Norwich. The agreement with the Bridlington Crag was not ver close, there being only six or seven species in common.

Mr. O. Fisher, from a careful study of the country from Orford t Thorpe, convinced himself that the "Chillesford Crag" was in a intermediate position between true "Red Crag" and the "Fluvio marine Crag" at Thorpe, near Aldborough. Assuming this to be o the same age as that of Norwich, his arrangement is as follow opposed to which are the results of Mr. S. Wood's examination o the same district in the following year:—

O. Fisher, 1865.		S. Wood, 1866.
Fluvio-marine, or Norwich Crag.		
Chillesford Clay,	}	Chillesford Clay.
Mya-bed, resting on	}	
Red Sands.		Fluvio-marine Crag.
Red Crag.		

Differences of opinion as to detail, both of facts and inference might be cited, as is well-known to those geologists who have at tended to this very complicated portion of the geological record but thus much seems to have been ascertained, that the so-calle Chillesford Crag is rather a subordinate member of the marine Glacia period than an upper member of the Crag, and that it is referable t a time when the climatal conditions, as indicated by the marin mollusca, had undergone a great change.

Bridlington Crag was a name given to a set of marine clay-beds occurring at that place, about 30 feet thick; they overlie an accumulation of chalk flints derived from the subjacent Chalk.

Mr. S. Wood, in his Monograph, included these beds in the Crag, and considered them the equivalents of the Norwich Crag (1855).

I am not aware that the fauna of these beds attracted any particular attention till Mr. S. P. Woodward prepared his general list of the Norwich Crag accumulations for Mr. Gunn's essay. In 1864 he undertook a fresh examination, not from lists, as before, but from original specimens from Mr. Bean's and Mr. Leckenby's collections; this led him to the unexpected result that the Bridlington Crag could no longer be considered an equivalent of the Norwich Crag. The list of marine testacea had been increased to 64 (or by more than 20); of these, 35 are met with in the Norwich Crag, whilst 29 species (or one-half) are now living in seas north of Britain, the proportion of Arctic shells in the Norwich Crag being only one-sixth.

Mr. Woodward next compared the Bridlington fauna with that of the Clyde beds belonging to the close of the "Glacial period," and with this result, that they differed very nearly as much from these as they did from the Norwich assemblage; they must therefore be separated from the Crag series.

The Bridlington testacea are more indicative of Arctic climatal conditions than any assemblage in or about the British Islands. As an assemblage, it is wholly recent and living, and marks a stage in the northern submergence during the Glacial period, when the Arctic-basin marine fauna had extended itself over our seas.

SHELLS PECULIAR TO BRIDLINGTON.

Fusus gracilis, var. *ventricosus*.
Trophon clathratus, L. (*Bamffius*).
Natica occlusa.
——*Bowerbankii*.
Trichotropis borealis.
Turritella erosa, Couth. (*clathratula*).
Margarita elegantissima, Bean.
Cimoria Noachina.
Dentalium Tarentinum (*entale*).
Montacuta bidentata.
Cardita analis ? (*borealis* ?).
Astarte borealis, var. *semisulcata*, Leach.
—— *mutabilis*.
—— *crebricosta* ?

The Bridlington beds seem to correspond most nearly in age with those which, in Norway, M. Sars has distinguished as his Glacial formation.

Mr. Trimmer candidly admits that, when engaged in the "Geology of Norfolk" for the Royal Agricultural Society (1847), it was the adoption of a theory guiding his observations that enabled him to disentangle and harmonize all that mass of confused materials (Drift) which till then had so perplexed him; "each part then soon fell into its appropriate place." In this case, fortunately, the adopted theory was right, namely submergence and emergence—that the accumulations of the erratic group indicate a long period of accumulation over a terrestrial surface, followed by denudation as it rose again. For the whole of the period and its products, he proposed two groups of Drift—a lower and an upper. He seems to me to have recognized certain distinctive characters in the Lower Drift, which are the indications of the different conditions of accumulation concerned, [illegible] as the masses of fragmentary chalk with little or no admixture of other matter; [illegible] angular fragments, very slightly worn [illegible] and, on the other hand, the [illegible] boulders from greater distance; the transfer of this chalk material in the direction of Cromer [illegible]

Mr. Searles Wood, jun., had proposed for the "Drift or Glacial" series of the upper Kainozoic period an upper and a lower; he subsequently subdivided the lower, whence resulted:—

	ft.
1. Upper Drift, or Boulder-clay, maximum thickness	[illegible]
2. Middle Drift, maximum thickness	[illegible]
3. Lower Drift (boulder, till, and contorted beds of Cromer)	[illegible]

The Lower Drift immediately overlies the Chalk, except near [illegible] place, where it has what has been designated as the "Norwi Crag" at its base, the inland facies of this division being a mass merely remanié chalk rubble, without any admixture of other materials; this facies does not extend east of Norwich. Beyond and to the coast the Lower Drift is of sand; above, on the coast section is a blue till with boulders, horizontally bedded, passing up into very contorted beds. These lower sands west of Cromer contain the débris of the underlying Lignite beds. In the case of th inland, as of the coast-line facies, the character of the accumulatio is immediately dependent on the subjacent beds. When we bea in mind that previously to the accumulation of this Drift-series th boundary line of the Nummulitic formation by Sudbury and Ipswic had been well defined, and consequently that High Suffolk an Norfolk presented a range of bare Chalk hills, we are prepared t adopt the supposition of Mr. S. Wood, jun., and refer this divisio of the series to the agencies of subaërial glaciation.

C. Postglacial.—In the Nar valley, which joins the Ouse at Lyn is met with a well-known set of marine depositions of this ag They extend some nine miles along its course, and occupied wh must have been a creek at the time when the whole of the Bedfor level was sea—an inland extension of the Wash. Mr. Rose calle attention to this stage of the Kainozoic series in 1836, and assigne it to its true position. This deposit, which is 40 feet in thicknes and 60 above the present sea-level, contains 27 species of testace all of which are also North-Sea shells.

These subjects have engaged many speculative and ingeniou minds, from the middle of the last century, down to those no actively at work here—such as Arderen, William Smith, the fath of Geology, the Taylors, Robberds, the Woodwards (of whom fou generations), Clarke, Mitchell, Trimmer, Gunn, Osmond Fishe But I should be wanting to the place in which we are now me wholly unworthy to fill this chair, wanting to the great subje which assembles so many here, wholly forgetful of my own oblig tions, if I were not mindful that Norwich may claim with Cambrid joint ownership in the Woodwardian Professor—the Rev. Can Sedgwick.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—Norwich, August 19th, 1868. List of Papers read in Section C.—Geology.

President:—R. A. C. Godwin-Austen, F.R.S., F.G.S.

Rev. O. Fisher—On the Denudations of Norfolk.
G. Maw—On the Sequence of the Deposits in Norfolk and Suffolk superior to the Red Crag.
S. V. Wood and F. W. Harmer—On the Glacial Structure of Norfolk and Suffolk. (See *ante*, page 452.)
J. E. Taylor—The Norwich Crags and their relation to the Mammaliferous Bed.
A. Bell—On the Molluscan Fauna of the Red Crag.
W. Pengelly—Fourth report of Committee for the exploration of Kent's Cavern, Devonshire.
W. Pengelly—On the condition of some of the bones in Kent's Cavern.
G. Maw—On the sequence of the Deposits in Norfolk and Suffolk superior to the Red Crag.
W. S. Mitchell—Report of Committee on Leaf Beds of the Hampshire Basin.
E. Whymper—Report of the "Greenland Plant Beds' Committee."
C. B. Rose—On the Conchoidal Fracture of Flint as seen on Flint-faced buildings in Norwich, &c.
C. Moore—Report on the Fossil contents of Mineral Veins in the Mendips, &c.
J. Bryce—Report of the Earthquake Committee for Scotland.
Rev. J. Gunn—On the alternate elevations and subsidences of the land, and the order of succession of the strata.
H. Woodward—Fourth Report on Fossil Crustacea.
H. M. Jenkins—On the Tertiary deposits of Victoria.
Dr. J. Lowe—On the Carstone of West Norfolk.
Professor Otto Torell—On some new fossils from the Long Mynd Rocks of Sweden.
J. W. Salter—On a new *Pterygotus* from the lowest Old Red Sandstone.
C. Jecks—On the ferruginous Sandstone of the neighbourhood of Northampton.
C. W. Peach—On the Fossil Fishes of the County of Cornwall.
S. Sharp—On a Remarkable Petrifaction in Northamptonshire.
C. B. Rose—On the Crag at Aldeby in Norfolk.
Dr. R. J. Mann—Notes on the Character of the Coal Field in Natal.
Dr. P. M. Duncan—First Report on British Fossil Corals.
Dr. P. M. Duncan—On the Genus *Clisiophyllum* from the Scotch Coal Field.
W. R. Grove—"Artifical Rocking Stones."—An Experiment.
C. Moore—On New Discoveries connected with Quarternary Deposits.
H. G. Seeley—On the Classification of the Secondary Strata of England.

Professor H. Coquand—The Cretaceous Strata of England and the North of France, compared with those of the West, South-west, and South of France, and the North of Africa.
J. Evans—On some Cavities in the Gravel of the Valley of the Little Ouse. (See *ante*, page 443.)
Dr. E. Crisp—The Skeleton of a Fossil Whale, recently found on the Eastern Coast of Suffolk.
H. Hicks—On some Recent Discoveries of Fossils in the Cambrian Rocks,
Rev. J. Brodie—Geological Changes that have taken place on the Coast of Britain in recent times.
C. B. Rose—On the Thickness of the Chalk in Norfolk.
Rev. W. Fox—On Skull and Bones of Iguanodon.
H. G. Seeley—On the Relations between Extinct and Living Reptiles and on the Present State of our Knowledge of the Pterodactyle.
J. Thomson—Notice of certain Reptilian Remains found in the Coal-measures of Lanarkshire.
H. Clarke—Note on the Western Asia-Minor Coal and Iron Basin, and on the Geology of the District.
Dr. Mann—The Resemblance and Contrasts of the Climate of Mauritius and Natal.
Dr. Mann—Remarks on the Gold Fields of South Africa.
Professor Tennant—On the Recent Discovery of Diamonds in the Cape Colony.
Rev. C. G. Nicolay—On the Diamonds of Brazil.
J. L. Lobley—On the Range and Distribution of the British Fossil Brachiopoda.
S. Jenkins—On the Noted Slate Veins of Festiniog.
J. Curry—On the Formation of Certain Columnar Structures.
Professor Göppert—On the Inapplicability of Fossil Plants to support the Theory of Gradual Transformation.
E. R. Lankester—The Oldest Beds of the Crag.
Rev. J. Brodie—The Earthquake Tremors which seem to have Preceded the Elevation of the Scottish Coast.

CORRESPONDENCE.

MR. WITCHELL ON THE COTTESWOLD VALLEYS.

Sir,—For many months past I have not troubled you with any communication on the subject of denudation, as I have been almost constantly travelling in the hilly districts of Devonshire, the Welsh borders, and North Wales. Since I last wrote, very little on this subject has appeared in your Magazine, excepting an article by the accomplished disciple of Playfair, Mr. Geikie, who advocates doctrines for which few geologists would be prepared, and which are at open variance with the maxim (hitherto regarded as established) laid down by Mr. Whitaker,[1] that in comparison to the huge and "continental" denudations and removals of rock by the sea, "the present irregularities of the earth's surface are mere scratches;" and an abstract of a paper by Mr. Witchell on the Denudation of the Cotteswolds.

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[1] See Geol. Magazine for Oct. and Nov. 1867, Vol. IV.

Mr. Witchell believes that the combes of the Cotteswold valleys have been formed by the springs they contain. Before, however, the occurrence of springs in combes can be regarded as furnishing any evidence that the combes were excavated by them, it is necessary that the following questions should be answered. Do the springs along a line of escarpment occur generally at intervals such as might lead one to expect to find them in the parts which run back into combes? Is there sometimes more than one spring in a single combe? Do springs in combes occur on the sides, at the back, at the mouth, or in apparently accidental positions? [I once saw a subterranean stream, not far from Crickley, flowing out of the side of a short valley, in such a way as to show that it could have had little to do with the excavation of the valley.] Are not the springs in some combes the indirect result of the surface-drainage of the areas of the combes? Is it a fact that *all* the Cotteswold combes contain springs? Supposing the connection between the Cotteswold combes and springs to be so great as Mr. Witchell asserts, then the dry combes of the Chalk and other districts could not have been formed by springs, for it is as reasonable to believe that springs have broken out in combes after their formation, as that springs have disappeared from combes. With regard to the supposition that the sea would not have selected the parts of escarpments containing springs to hollow them back into combes, it may be remarked that these are the parts which would have yielded most readily to its undermining action, and the parts where coast-slips would have chiefly occurred. I believe that the denudation of the Cotteswold hills (which can only be thoroughly understood by considering it in connection with other districts) has been effected as follows:—Tidal and other currents must have furrowed the original table-land (if a table-land free from considerable undulations ever existed) into shallow passes[1]—one side of these passes, owing to its being the *upcrop* side, the side exposed to wind, or the side on which currents chiefly impinged, was rendered steeper than the other,—while the sea occupied the passes, coast-slips occurred on the parts moistened and loosened by springs—the sea swept away the slipped débris, cleared out and smoothed the irregular vacancies left by the slips so as to give rise to the curvilinear hollows called combes. The drift on the upper slopes of the Cotteswold valleys is of much the same nature with that on the flat tops of the plateaux. It is just what might have been left by currents, or waves acting under conditions unfavourable to the rounding of stones. In many places it forms an extensive and uniform covering or *lining*, which could not possibly have been left by small streams; while I am prepared to prove, from a long series of observations, that, in common with other slope drifts in England and Wales, the bulk of it is not a mere disintegration *in situ*, but the effect of lateral displacement in a great measure irrespectively of the form of the ground. D. MACKINTOSH.

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[1] Both ends of these passes have since been deepened by streams, in many places to a very great extent; for atmospheric denudation is more active in some parts of the Cotteswold district than in any part of South Britain with which I am acquainted.

BIRKENHEAD, 12*th Sept.*, 1868.

ON THE DISTURBANCE OF THE LEVEL OF THE LAND NEAR YOUGHAL, ON THE SOUTH-EAST OF IRELAND.

SIR,—In your May number, which has just reached me, I find Colonel Greenwood considers me in "error" when supposing depression of the land necessary to account for facts observed at Youghal; but in the remarks which follow this I fail to see that the author of "Rain and Rivers," while admitting one of my propositions, proves the other wrong.

If it be granted that as the sea erodes a line of coast *at rest* the beach may travel landward, surely while the sea erodes "the whole line of coast," the peat beneath the travelling beach ought to be eroded also, and dispersed instead of being submerged. The peat under Youghal Bay, however, not having been eroded and dispersed, we may conclude that the land there was not at rest during the submergence of the peat.

But the gist of Colonel Greenwood's argument lies in his assertion that "the stream or the rain valley cuts its estuary far deeper [how much?] even than low-water-mark," forming an arm of the sea.

Applied to the case in point, that is to say, that the rain valley excavated its estuary as much lower than sea level as is the surface upon which the first peat was formed, now far out under Youghal Bay. This point must be at a considerable depth, if my memory and information be correct, for I have seen from three to five fathoms water marked upon a chart somewhere about the place indicated by fishermen as the outer limit of where peat is known to occur. To this depth must be added the unknown thickness of the peat, which in parts of Ireland not uncommonly exceeds 20ft. However, taking it at 10ft., we have thus a rain-and-river valley excavated by these agencies to a depth of from 28ft. to 38ft., or, it may be, 40ft. or 50ft., below the level of the sea at low water!

Depression not being admitted, is it not fair to ask whether the beach of that period may have been of this height, and what kept the sea out of the valley before the beach was thrown up by some storm, so that peat could grow behind it? I may also, I trust, be excused for asking, if the stratified sand, gravel, and clay, with flints, which forms Clay Castle Hill, was thrown up to a greater height than 91ft. by storm, or ordinary waves, or otherwise, how does it come to contain sea shells at such a considerable elevation as it does?

I must here confess that "*raised beach*" is not an expressive term for such a local accumulation as that of Clay Castle, and was only used for want of a better. All low ground gradually elevated from the sea would, at one time or another, have formed its beach (as was once remarked to me by Professor Jukes), therefore one locality has no better claim than another to the name, used in a general sense.

The materials of this hill differ considerably from those of the lower, clean-rolled, and cast-up-beach in its vicinity, though they were, doubtless, accumulated under water and disturbed by waves, when they formed the shore or beach, while being elevated to their present position. Had I the means of reference here, I dare say it would be easy to show, from heights upon the Ordnance six-inch map, that the slope of the boggy valley is gradual from higher levels inland towards the sea, and, probably, charts of the coast would permit nearly the same slope to be carried out beneath Youghal Bay. Upon such a slope peat could be formed when the land stood higher, and if depression occurred the results would be exactly those which now appear; without the necessity for so strong an assumption as that the valley was cut down by rain and rivers to 30ft. or 40ft. below sea level at low water, during a period at which sea water was obliging enough to forego the law of seeking its own level in order to allow a deep growth of peat to accumulate.

I regret to add that I have no copy of "Rain and Rivers" to which I might refer for answers to the above questions; one of the old edition was lent to me a long time ago, but I have, unfortunately, never been able to obtain the last, although I have made several efforts to do so.

The Chalk flints may be quite according to rule, but their occurrence is peculiar in this, that they are not usually found in the detrital deposits of the south of Ireland, or other parts of the coast. How far they extend from Youghal eastwards is not, so far as I am aware, as yet discovered. A. B. Wynne.

Bhooj Kutch, Western India, *July 25th*, 1868.

FOSSILS FROM BUFFALO RIVER, BRITISH KAFFRARIA.

Sir,—Permit me to explain the seeming discrepancy which occurs at pages 202 and 204 of the May number of the Geological Magazine. At page 202, under the heading "Explanation of Geological Sections," the 800 feet refers to the height at which marine shells have been *observed*, (viz., St. Luke's Mission Station, Newlands, British Kaffraria). At page 204, under the heading "List of Fossils," the 220 feet refers to the height at which the *specimens sent* were *obtained*, (viz., Panmure, British Kaffraria). Geo. M‘Kay.

East London, Cape of Good Hope,
26th June, 1868.

THE PLEISTOCENE FRESHWATER DEPOSIT AT HACKNEY DOWNS.

Sir,—My attention has only just been directed to a statement by Mr. Alfred Tylor, which appeared in the Geological Magazine, August, 1868, p. 392, in reply to which I can only say that Mr. Tylor must have been misinformed, as I never received the series of specimens referred to from Mr. Skertchly, nor have I the pleasure of knowing that gentleman. The species of Land and Fresh-water Mollusca enumerated in the Natural History Repertory, were collected by myself in company with my friend, Mr. J. W. Bailey, of Fenchurch-street.

Had they been given me, as stated by Mr. Tylor, I should not h committed myself by publishing the list without first obtaining Skertchly's permission, and without due acknowledgment. I m ask you, therefore, to insert this, in correction of Mr. Tylor's sta ment, which is erroneous. GEORGE J. SMITH.

ISLINGTON, *September* 5, 1868.

ORMEROD'S GEOLOGICAL INDEX.

A Second Edition of this work, including the papers contained the Quarterly Journal for 1868, will shortly be published. G logists are requested to communicate notices of any errors or om sions that exist in the first edition to the author, at the followi address,

G. W. ORMEROD, Esq.,
Chagford, Exeter.

FOSSILS FROM THE COAL-MEASURES.

SIR,—I have recently collected, or had forwarded to me, thousa of specimens of fossil jaws, teeth, scales, spines, ribs, vertebræ, a other fish-remains from the Low Main Coal Shales of Northumb land.

As a matter of course, several of the specimens are duplicates, a are not required for the cabinet. I shall therefore have great pl sure in forwarding a tooth or scale to any of your readers who w send me a stamped and addressed parchment luggage label.

The fossils collected are for the most part of the following genera: *Rhizodus*, *Megalichthys*, *Rhizodopsis*, *Ctenodus*, *Ctenoptychius*, *Pleu canthus*, *Gyracanthus*, *Strepsodus*, *Acanthodopsis*, etc., myriads *Entomostraca*, and a few reptile remains. T. P. BARKAS.

NEWCASTLE-ON-TYNE, *September* 8, 1868.

DISCOVERY OF *BOS PRIMIGENIUS* IN THE LOWER BOULDER-CLAY OF SCOTLAND.

SIR,—In my humble opinion, it is doubtful if Mr. Geikie is corr in placing the discovery of the above fossil in the true Till or Low Boulder-clay of Scotland.[1] He says that "the fossil was imbedd some few feet deep, in a soft clay or mud, interlaminated with lin and beds of sand, and occasional layers of fine gravel." Mr. Geik takes this bed as being intercalated, with the Lower Boulder-cla whereas the Lower Boulder-clay rises up through this stratified be (if I may so speak), throwing it out altogether, for more than o hundred yards in the cutting,—a fact that Mr. Geikie has overlooke both in his sketch section, Fig. 1, and in the letterpress descriptio This has led him to consider the clay that underlies the stratifi bed as identical with that which overlies it. They are certain distinct. The clay that is seen rising from under the stratified bed the true Till; and consists of a tough dark blue clay, full of ston and quite free of sand. It is seen rising from under the stratifi bed, near the place where the fossil was found, and occupying t north bank for one hundred yards westward; it is seen again dipping under the stratified beds—the clay that overlies the stratified bed is of a reddish, or as Mr. Geikie describes it, "dark brown" colour mixed with sand and gravel, and is altogether freer than the under clay.

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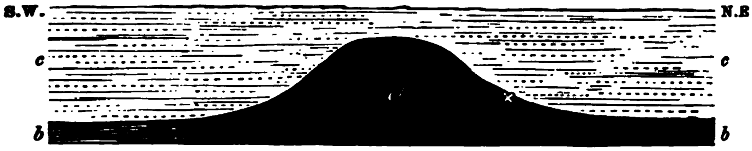
[1] See Mr. James Geikie's article in the September Number of the GEOLOGIC MAGAZINE, p. 393 (with two woodcut sections).

To account for these stratified beds, Mr. Geikie supposes that "one large lake," or more probably a series of small lakes, may once have occupied the area between Caldwell and the place where the fossil remains of the great ox were obtained." This surmise is most likely correct; yet it is doubtful if a glacier passed up the valley after the deposit of the stratified beds. They have no appearance of being disturbed by land-ice having passed over them. Into this I do not enter, it is enough to point out that these upper beds are distinct from the true "Till," and may belong to deposits long posterior to it.



SECTION OF NORTH BANK, WHERE *Bos primigenius* WAS FOUND.

a. Lower Boulder-clay.
b. Stratified bed of fine mud, or clay, free from stones.
c. Clay with sand and gravel.
× Place where the fossil was found.[1]

ROBERT CRAIG.

LANGSIDE, BEITH, *September* 10, 1868.

OBITUARY.

M. BOUCHER DE PERTHES.

On the 2nd of August last, at the ripe age of 79 years, there passed away from among us Monsieur Jacques Boucher de Crèvecœur de Perthes, Officer of the Legion of Honour, President of the Imperial Society of Emulation of Abbeville, a member of numerous learned societies, and a Foreign Correspondent of the Geological Society.

Throughout the whole of the civilized world there are few names better known than that of M. Boucher de Perthes, who in the present day must be regarded as the first person who directed public attention to those early works of man, the flint implements imbedded in the Post Pliocene gravels of our river valleys. Without detracting from the merits of Dr. Ceselli, of Rome, or of our own countryman, Mr. Frere, it must be confessed on all hands that to Boucher de Perthes and his labours is due the first impetus which was given to the study of the Antiquity of Man, which within the last few years has made such rapid progress, and which has enlisted the energies of so many votaries of science.

His *Antiquités Celtiques et Antédiluviennes,* printed in 1847, and published in 1849, will always be regarded as the starting point of this study; and though at the outset this work was treated in his own country with coldness and neglect, and though his views were regarded as unworthy of recognition by those better versed in other branches of geology, yet the strong convictions of Boucher de Perthes at length prevailed, and aided by the late Dr. Falconer, Mr. Prestwich, and other English geologists, his discovery of artificially formed implements, embedded in the same deposits with animals belonging to a fauna now for the most part extinct, was in 1859 amply corroborated, and is now universally accepted.

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[1] The fossil was found on the top of the stratified bed, and could not be more than four feet from the surface.

After many years of waiting, of argument, and of disappointment, M. Boucher de Perthes had, in the last decade of his life, the proud satisfaction of seeing his discoveries duly appreciated, and the study of the early history of man, to which he had so long devoted himself, taken up and successfully prosecuted by other labourers, who recognized him as their precursor, and, in a certain sense, as their master.

Those who, in the early days of the discussions as to the authenticity of these implements, and the circumstances of their discovery, had the opportunity of making the acquaintance of M. Boucher de Perthes at Abbeville, and of studying his collections, and visiting with him the deposits in the valley of the Somme, will always remember with gratitude the hearty kindness, the quick intelligence, the true liberality, and the courteous hospitality of the genial old man; and even those who had the misfortune to differ from him on the subject of the famous Moulin Quignon jaw, could never for a moment doubt his perfect sincerity and candour, even if they thought him somewhat too facile of belief.

The choicest part of his collection of primeval antiquities he presented, during his lifetime, to the National Museum at St. Germain-en-Laye, of which it will long remain a distinguished ornament; but numerous other museums and private collections all over the world are enriched by his munificence, for he gave with no niggardly hand.

A bachelor, with comfortable means, he had long given up his appointment as Directeur des Douanes, and had devoted himself to study and travel. His literary productions are voluminous. Besides his numerous works of greater or less importance relating to the Antiquity of Man, he published accounts of his Travels in Russia, Denmark, Spain, and other countries, written in a light and pleasant style; and he also entered the field of fiction, having written more than one novel; while occasionally his thoughts took a political turn, and he wrote of the prospective future of England, or deserted the Antiquity of Man to speculate on Woman and her Destiny.

His private correspondence with all parts of the world was immense, but so was his industry; and though of late years the gout was apt to interfere with his powers of writing, yet his pen was in his hand many hours each day. Those who have visited his home at Abbeville cannot fail to recal with affectionate remembrance the figure of the veteran seated at his table, with his papers around him, in the little study so profusely decorated with porcelain, where, alas, his place shall know him no more.

PEDUNCULATED & SESSILE-EYED CRUSTACEA.

THE
GEOLOGICAL MAGAZINE.

No. LIII.—NOVEMBER, 1868.

ORIGINAL ARTICLES.

I.—On a Newly-discovered Long-eyed *Calymene* from the Wenlock Limestone, Dudley.

By Henry Woodward, F.G.S., F.Z.S., of the British Museum.

[PLATE XXI.]

IT is more than a century since the "Dudley Locust," or 'Trilobite,' was first figured and described,[1] and the locality where it it is found, is rendered famous by the researches and writings of Sedgwick, Phillips, Forbes, Murchison, Salter, Davidson, and a host of other geologists and palæontologists, who have been attracted thither at various times by the grand geological features of the district or by the matchless beauty and endless diversity of its well-preserved organic remains.

Nor have the advantages, which this locality offers, been lost sight of by the members of the Dudley and Midland Geological Society, whose well-stored cabinets attest the earnest interest they all take in procuring and preserving the choicest Corals, Mollusca, Crinoids, and Trilobites, which the Wenlock Limestone and Shale so abundantly afford.

To one of these gentlemen, Mr. E. Hollier, of Dudley, I am indebted for the opportunity of examining and describing the remarkable Trilobite which forms the subject of this communication.

From the time of the establishment of the genus *Calymene* by Brongniart in 1822,[2] the "Dudley Trilobite" may be said to have been very well known, described, and figured, and its portrait has appeared in almost every geological work in which fossils have been noticed from that time down to the present day.

For the best description and illustration of this and many other genera of British Trilobites we are indebted to Mr. J. W. Salter. (See Geological Survey, Memoirs, 1849-53; and Monographs of the Palæontographical Society[3] for 1862–66), to Part II. of which latter work we refer the reader for a full description of the genus *Calymene*.

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[1] Lyttelton, Phil. Trans. 1750, vol. xlvi. p. 598, pl. i. and ii.; Mortimer, ibid. p. 600; Mendez da Costa, ibid. 1753, vol. xlviii. p. 296; also Guettard, Wilckens, Klein, Walch, Beckmann, etc., 1757 to 1773.

[2] Brongniart and Desmarest, Hist. Nat. Crust. foss. 1, pl.i.

[3] Four parts have already appeared, with upwards of 30 plates and above 700 figures, together with descriptions of 114 species of Trilobites.

At page 90, Mr. Salter writes of *Calymene* as follows: "One of the most graceful and compact of all the Trilobite group; the head and tail well developed, but not extravagantly so; the former with a three-lobed glabella, very convex and narrowed in front, and with *prominent supine eyes, which have evidently a very thin cornea, in which, only very rarely, the lenses are visible;*[1] a thick margin to the head, the suture being in front submarginal and subtending a broad rostral shield, etc., etc." The passage we wish to call attention to is printed in italics.

All collectors of Trilobites can corroborate the above observation of Mr. Salter's; nay, more, it is rarely, if ever, that the cornea itself is preserved in *Calymene*.

Out of the numerous specimens which have come under my own notice, I have seen but one. The specimen consisted of part of the head of a small *Calymene Blumenbachii*, carefully worked out by that veteran collector of Dudley fossils, Mr. John Gray, of Hagley, some of whose choicest specimens of Crinoids and Trilobites (beautifully developed with his own hands) now adorn the Geological Gallery of the British Museum.[2]

The aspect which the eye ordinarly presents in *Calymene* is that of a lenticular aperture, with a thickened and often considerably raised margin, the smoothness of the edge of which depends—(certainly in some out of the many specimens which I have lately examined)—upon the skilful finish put upon it by the Dudley "Fossilists," who have for many years pursued fossil-development as an important branch of native industry.[3]

Knowing these things, it will not seem surprising that I looked with mingled feelings of interest and distrust at the "carte de visite" of the remarkable Trilobite figured in the centre of our plate, and desired, before all things, to see the original specimen. This was duly sent me up, and I looked at it still more earnestly, and appealed to other eyes than mine to examine it critically, and I am glad to say that my colleagues all confirmed me in my decision of its genuineness.

In all points, except in the remarkable eye-peduncles, the specimen appears to be a true *Calymene Blumenbachii* (see Plate XXI. Fig. 1). Indeed, there are specimens in the Museum collection which match Mr. Hollier's Trilobite most exactly, save in this one particular.

I could only call to mind one other instance of a Trilobite having equally long eye-stalks, the ***Asaphus Kowalewski*** from the Silurian of Russia (see Plate XXI. Figs. 4 and 5).[1]

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[1] "Hall, in his 'Palæontology of New York,' has figured the lenses. I have never seen any traces of them."—J.W.S.

[2] This little specimen was sent me privately in a letter by Mr. Gray, some long time since, and, to my regret, I am unable at this moment to light upon it, or I should have figured it on the accompanying plate.

[3] Mr. Gray informs me that for fifty years the miners have not only collected and developed Trilobites, but even *made them* when they did not turn up in sufficient abundance. He adds, "New and undescribed species are still to be purchased, composed of parts of *Calymene* and *Phacops* united together, either by accident or by the aid of a knife and a little gum." I have myself seen (in the possession of Dr. Grindrod, of Malvern) an *Ampyx nudus* cleverly made out of the limestone with the help of the tail of a *Phacops Downingiæ*.

But the sessile or pedunculated form of the eyes in the ***Crustacea*** cannot be held as peculiarly characteristic of any one order. If this were insisted upon, we must classify such forms as ***Squilla, Mysis, Phyllosoma,*** belonging to the ***Stomapoda,*** with the true Decapod ***Crustacea.***[2]

It must, however, be borne in mind that ***the eye itself*** (and ***not the peduncle,*** or its exact form), is the essential organ, the peduncle being merely a form of stand or support for the more convenient adjustment of the lens which conveys, by the optic nerve to the brain, the impressions of external objects coming within its range.

If we turn, for a moment, to recent Crustacea we find among the Crabs (*Decapoda-Brachyura*) the greatest possible variation in the development of the eye-peduncle. Thus in the Common Crab (*Cancer pagurus*), the Pea-Crab (*Pinnotheres*), and in *Ixa, Arcania, Ebalia,* and *Philyra* (among the *Leucosiadæ*), the peduncle is scarcely, if at all, elongated beyond the orbit, in the concavity of which it is articulated.

In *Gonoplax* (one of the "Quadrilateral" Crabs) Pl. XXI. Fig. 9, it is half an inch in length, and the eye is placed at its extremity. In *Podopthalmus vigil,* one of the very active pelagic forms of Indian Crabs, the eye-stalks are of prodigious length, and are furnished with a second articulation near the summit, enabling the eye to be directed more readily upon any special object. In *Ocypoda ceratophthalma* (Pl. XXI. Fig. 10) the eye is placed midway upon the peduncle, the eye-stalk itself being developed beyond the cornea in the form of a somewhat blunt spine. The same spine-like prolongation of the eye-peduncle beyond the eye itself is seen in *Gelasimus platydactylus,* one of the "Calling-crabs" common on the sea-shores of China and Japan (see Pl. XXI. Fig. 8). This character is not however, of more than specific value in either *Gelasimus* or *Ocypoda,* species occurring in both genera (all but identical in other respects), in which the eyes are really terminal in position.

In all these higher forms the eye-peduncle has an articulation at its base, and is protruded from or withdrawn into the orbital fossa at the will of the animal by the action of the peduncular muscles.

In the recent sessile-eyed forms no such provision exists, the *cornea* being but slightly raised above the surface of the head-shield, as indeed in most of the Trilobites. The *Trilobita* alone offer an example of a fixed eye raised upon an immoveable eye-stalk.

Among the *Isopoda* there is an interesting living form, the *Ceratocephalus Grayianus* (White MS.)[3] from Flinder's Island, Bass's Straits (Pl. XXI. fig. 7), in which pseudo-eye-stalks (*p.p.*) are developed, but the eyes (*o.o.*) are at their bases on the sides of the head-shield, not upon these horn-like prominences which have, however, a strong resemblance to the eye-pedicels of Trilobites (Compare Figs. 1, 4, and 7. Plate XXI.)

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[1] For the original figures and description of this remarkable species of *Asaphus,* see Article XI. "Zwei Neue Asaphus-arten aus dem Silurischen Kalksteine des Gouvernements St. Petersburg," von N. Lawrow. Taf IV. and V., p. 239, in the Verhandlung. der Russisch-k. Mineral. Gesell. zu St. Petersburg, Jahrgang, 1855-56.

[2] In Bell's *British Stalk-eyed Crustacea* this has actually been done, but of course the *Stomapoda* are a perfectly distinct group.

[3] The original specimens are preserved in the British Museum.

Turning once more to the *Trilobita*, we have in our Plate, Figs. 3 and 5, illustrations of two species of *Asaphi*, *A. expansus* (Fig. 3), and *A. Kowalewskii* (Figs. 4 and 5), in which the specific difference appears to consist in the development of the eye-stalks in the one case and their suppression in the other.[1]

Mr. Hollier's specimen of *Calymene* (Fig. 1) and the old *Calymene Blumenbachii* (Fig. 2) offer a perfectly parallel case to that of the two Russian forms of *Asaphi* (Fig. 3–5). I am, of course, assuming that some out of the many specimens of *Calymene Blumenbachii* (perhaps by far the larger proportion) had sessile eyes placed upon the cheeks of the glabella; but I feel equally certain that so soon as Mr. Hollier's discovery is made known, many long-eyed *Calymene* will be discovered at Wenlock; perhaps they already exist in the cabinets of some of our Dudley friends, *quien sabe?*

It will be for Mr. Salter to reconsider this genus when, with a fresh stock of health, which he has been accumulating at Malvern and in Wales, he again vigorously takes up his pen and pencil and completes his admirable Monograph on the British Trilobites.

In order however to protect Mr. Hollier's discovery from being overlooked for want of a distinctive appellation, I propose to christen his specimen *Calymene ceratophthalma*,[2] which (although a rather long name) expresses well its specific peculiarity.

In consequence of the terminations being somewhat cut away by the man who developed the specimen, I am unable to define well the extremities of the eye-pedicels, but I have used dotted lines in the Plate to indicate what their perfect outline appears to have been. With respect to the formation of the eye-stalk it will be observed, by referring to Fig. 4, that it is partly composed of the glabella and partly of the cheek, or "facial" portion of the head-shield, the suture, which divides these regions, being clearly seen in the figure passing up each eye-stalk; the extension of the border of the glabella, forming what may be aptly called the "superciliary border" above the cornea of the eye, whilst the prolongation of the cheek or "facial" border forms the lower and exterior portion of the pedicel.

If we compare the two forms of eye-stalks we shall perceive that in *A. Kowalewskii* (Figs. 4 and 5) the eyes are very erect, and diverge but slightly from each other; in *Calymene ceratophthalma* (Fig. 1) the eyes-pedicels are directed forwards, being little raised from the plane of the body, and diverge widely from each other, curving outwards and forwards. I am inclined to the opinion that the depressed plane of the eye-stalks is partly due to compression, and that, normally, they would have been rather more elevated above the body; but they never could have occupied the same erect position which they do in *A. Kowalewskii.*

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[1] In the 4th edition of Murchison's "Siluria" (p. 357), a figure is given of the ordinary form of *Asaphus expansus*, Wahl., in which the eyes are quite sessile, and not at all elevated above the glabella, as represented at Fig. 3 in our Plate. Another example there figured, called variety *cornutus*, has its eyes more elevated than in our Fig. 3, but less so than in Figs. 4 and 5, Pl. XXI. The eyes in this front view are seen to diverge laterally, as in our *Calymene ceratophthalma*.

[2] From κέρας, a horn: and, 'Οφθαλμὸς, the eye = horn-eyed.

In glancing at the structure of the eyes in Insects we find only two genera with pedunculated eyes in the whole Class. These occur among the *Diptera; Diopsis subfaciata,* and *Achias oculatus,* having their eyes placed upon the extremities of long-fixed eye-stalks.[1]

Further investigation will no doubt afford additional information on this interesting discovery, meanwhile I have thought it so important that I have at once recorded it, that those best able may add fresh evidence in correction or corroboration thereof.

EXPLANATION OF PLATE XXI.

Fig. 1. *Calymene ceratophthalma,* sp. nov. Wenlock Limestone, Dudley. Figured of the natural size. (The cheeks and tail slightly restored.) From the collection of Mr. E. Hollier, Dudley.
,, 2. *Calymene Blumenbachii,* Brong. Wenlock Shale, Dudley. Coiled-up specimen; natural size. Figured to show the usual condition of the eyes (*o*).
,, 3. *Asaphus expansus* (natural size) from the Lower Silurian, Pulkowa, Russia. Side-view of a coiled-up specimen preserved in the British Museum.
,, 4. *Asaphus Kowalewskii,* (natural size), Lower Silurian, Pulkowa, near St. Petersburg (front-view of a coiled-up specimen; natural size).
,, 5. *Asaphus Kowalewskii,* (side-view of same; natural size).
,, 6. *Encrinurus variolaris,* side-view of a specimen from Dudley, in the British Museum, showing the somewhat prominent form of the eyes. (Nat. size.)
,, 6*a*. One of the eyes of the same enlarged to show the position of the suture and the cornea of the eye.
,, 7. *Ceratocephalus Grayianus* (White, MS.) (enlarged three times) from Flinder's Island, Bass' Straits. Coll. Brit. Mus.
Showing the sessile eyes (*o*, *o*) and the pseudo-eye-stalks (*p*, *p*).
,, 8. Eye-peduncle of *Gelasimus platydactylus,* showing the prolongation of peduncle beyond the cornea of the eye.
,, 9. Eye-peduncle of *Gonoplax angulata,* showing eye at the extremity of same.
,, 10. Eye-peduncle of *Ocypoda ceratophthalma,* showing prolongation of peduncle beyond the cornea of the eye.

II.—On the Elevation of Mountain Chains,[2] with a Speculation on the Cause of Volcanic Action.

By Rev. O. Fisher, M.A., F.G.S.

It is some months since I read a paper at the Cambridge Philosophical Society, to which reference has been made in your pages by Mr. Maw.[3] I do not think that I shall be out of order in sending you a short outline of the substance of it.

Mr. Maw's letter in the March number of the Magazine[4] led me to calculate what the horizontal pressure at any point of a thin, outer spherical shell of the earth might be, and the result I obtained was that which Mr. Maw has already communicated to you from a private letter of mine. If you take into consideration a spherical shell of a few miles thickness, and conceive it for a moment unsupported by the matter within, then the horizontal pressure upon each of the opposite sides of any cubical element of this shell will be equal to the weight of a column of rock of the same sectional area and density, and of the length of half the earth's radius. This would be sufficient to crush any strata, and is, I believe, the force to which the elevation of mountains is due.

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[1] Among the *Arachnida* there is a little spider in the genus *Walckenæra* (*W. acuminata*), the male of which has a tall and slender central fixed peduncle, upon which the eyes are placed, two at the summit and four midway on either side.

[2] See also Mr. Shaler's Article at p. 511.

[3] Vol. V. p. 294.

[4] Vol. V. p. 149.

But why should the outer crust have ever lost the support of the inner portions of the earth? Probably from the effects of contraction in cooling. Granites contract in volume in passing from a fluid to a crystalline state,[1] and the columnar structure proves the like for Basalts. It may be objected that this is not true of all bodies, for some, like water, expand in solidifying. But if it be true of those of which the outer layers of our globe chiefly consist, it is sufficient for my argument. Suppose then that the internal strata of the earth have lost some heat since the outer crust became consolidated, and we have a cause adequate to the elevation of mountain chains. In this view there is now nothing original (although I excogitated it for myself in 1841) except that, as far as I know, the approximate amount of the horizontal compressing force has not been calculated before.

It does not appear to me that this view requires us to suppose the interior of the earth to have been fluid before the mountains arose, but only highly heated. There are strong reasons, as Professor Sir W. Thomson and Mr. Hopkins have shown, against supposing the earth generally fluid internally. Sir W. Thomson, in his valuable paper "On the Secular Cooling of the Earth,"[2] expresses an opinion that "at depths greater than 100 miles, the whole mass, or all except a nucleus cool from the beginning, is (whether liquid or solid) probably at, or very nearly at, the proper melting temperature for the pressure at each depth."

But since it is rendered almost certain by other considerations that it is *solid*, we arrive at the conclusion that that solidity must be due to pressure. Remove part of the pressure and the matter must pass into a fluid state.

Here, then, it appears to me, we find an explanation of volcanic phenomena. Volcanoes, for the most part, follow mountain chains, and earthquake phenomena still more constantly do so.

Archdeacon Pratt has shown that the density of the Earth's crust beneath mountain chains is less than elsewhere,[3] and it seems natural that it should be so, if they be corrugations of the surface formed by lateral pressure; because the matter of which the mountain is composed will be partly supported by the pressure which elevated it. Hence there is a cause in diminished vertical pressure why the interior layers beneath mountains should pass into a state of fusion, and the water contained in them assuming, as it ascends, a gaseous state, will, under favourable circumstances of facility of exit, cause that ebullition of lava, in which a volcanic eruption essentially consists.

It is the general opinion at the present time, that trains of volcanoes are connected with internal lakes of molten matter: but no reason that I know of has been suggested for the elongated forms which these trains of volcanoes assume, frequently, as in the Andes, following lines of elevation. The theory now proposed offers an explanation of this fact. It also explains the intermittent nature of volcanic action, and the migration of volcanic conditions to different portions of the Earth's crust at successive geological epochs.

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[1] Jukes' Manual, p. 96.

[2] Trans. Roy. Soc. of Edinburgh (and Phil. Mag. Series 4, Vol. xxv.) § 16.

[3] Fig. of the Earth. 3d. Edn., Art. 116.

III.—ON *CLIMAXODUS*, OR *PŒCILODUS*; A PALATAL TOOTH FROM THE LOW MAIN COAL-SHALE, NORTHUMBERLAND.

By T. P. BARKAS, Esq.

IN the course of my recent investigations among the fauna of the Low Main Coal-shale in the county of Northumberland, which lies at an average depth of about 100 fathoms from the surface, I have found among numerous fish and reptilian remains three specimens of teeth that present the appearance of being vomerine in their nature. The tooth here represented in the woodcut, of the natural size resembles exactly in size and form another specimen which I have in my possession, the view exposed being the front aspect of the tooth. I have a third specimen, which exhibits the upper or attached part of the tooth; it has a sharp curved appearance, not unlike the back of a well-written letter S.

The only reference I can find to the tooth in question is in Sedgwick and M'Coy's "British Palæozoic Fossils;" in which work the genus is both figured and described under the name of *Climaxodus. Climaxodus* of M'Coy, and *Pœcilodus* of Agassiz are, I am informed, so nearly alike, if not absolutely identical in all their leading characteristics, that they may with propriety be, for the future, treated as one genus. If such be the case, then the older name *Pœcilodus*, given by Agassiz, ought to have the preference. But although Agassiz in his "Poissons Fossiles" (vol. iii. p. 174) names the genus *Pœcilodus*, and refers six species[1] to it, none of them have been either figured or described by him, and I am therefore without the means of determining the generic relationship to the teeth I have found.[2]

Assuming that *Climaxodus* and *Pœcilodus* are identical, I adopt the former name, which, although not the older, has the claim to be accepted, as it is accompanied by both figure and description. The following is the description of M'Coy's genus and species extracted from Sedgwick and M'Coy's "British Palæozoic Fossils," p. 620.

Genus, *Climaxodus* (M'Coy).

"Gen. Char.—Tooth longer than wide, gradually narrowing towards the front, with nearly straight sides; anterior part of the crown crossed by broad, imbricating, transverse ridges at right angles to its length; surface minutely punctured.

"The above generic name has reference to the remarkable step-like character of the ridges which cross the anterior part of the tooth at regular intervals. The broad posterior part of the tooth is without ridges, and resembles a *Psammodus*. In the fact of its being as it were small-ridged *Psammodi*, these teeth are allied to the genus *Petalodus*; but all the true *Petalodi* are inequilateral mussel-shaped teeth, consequently placed in pairs in the mouth, and have the ridges oblique; the *Climaxodi*, on the contrary, are equilateral, and were therefore most probably mesial in position, and the ridging is transverse.[1] I am aware of one species in the Armagh limestone, and the following, *Climaxodus imbricatus* (M'Coy); the only specimen I have access to at present of this species is imperfect at each end, being seven lines long, five and a half lines wide at the broad end, and three lines wide at the anterior end; the anterior portion of the crown is crossed by seven transverse imbricating ridges in a space of four lines, the posterior ones are three-fourths of a line apart, and have a double curvature arising from a small backward wave in the middle, the anterior ones are closer, and pass with a slight forward curve across the tooth; all the imbrications have a backward curve at their extremities, giving them the appearance of lapping round the crown, and all have their free edges directed backwards, so as to resemble a row of *Petalodi* or other shark's teeth soldered together in the position they usually occupy, one behind the other; the posterior half is without ridges; the whole crown is slightly convex at the sides and concave in the middle; the surface is dull, and seen by the lens to be finely punctated."

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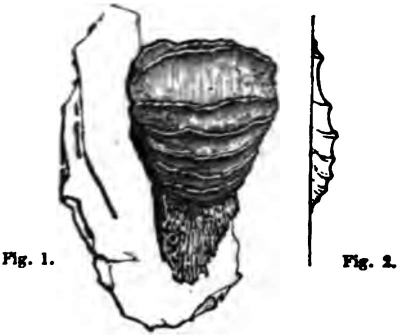
[1] *P. angustus, P. Jonesii, P. obliquus, P. parallelus, P. sublævis, P. transversus.*

[2] Certain teeth from the Carboniferous shale of Carluke, in the British Museum, have been named *Pœcilodus obliquus*, Agassiz.

"*Position and Locality.*—Rare in the dark impure limestone overlying the main Carboniferous limestone of Derbyshire."

"The above is figured pl. iii. G, fig. 5, natural size; fig. 5*a*, portion of surface of ditto magnified."

The following is a brief description of the tooth now figured (see Woodcut):—



Climaxodus ovatus, sp. nov. Low Main Coal-shale, Northumberland (Nat. size).
Fig. 1. View of surface of the tooth. Fig. 2. Side-view, to show elevation of crown of tooth.

Gen. Char. Tooth longer than wide, rapidly narrowing towards the back, the entire crown crossed by broad, transverse ridges at right angles to its length; surface irregular and smooth. The first ridge is one-fourth the length of the tooth from its anterior part.

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[1] May not these equilateral teeth have been the vomerine, and the oblique teeth, called *Pœcilodus*, have belonged respectively to the right and left rami of the lower jaw of the same fish, their structure and general similarity of form being the same?—Ed. Geol. Mag.

Climaxodus ovatus, sp. nov. The specimen is perfect, the length being one inch, width at broadest part seven-tenths, and at narrow posterior end five-tenths; the crown is crossed by five transverse ridges, the distance between the ridges uniformly diminishes from front to back of tooth; the crown is considerably convex except between the first transverse ridge and the anterior edge of the tooth, where it is slightly concave; the summit of each ridge is marked at right angles to the ridges, or from front to back of the tooth with close, nearly parallel lines consisting of a cream-coloured irridescent substance. The tooth is attached to a long plate, the length of which is one-third greater than that of the tooth, and towards the posterior part of the tooth the supporting plate presents a root-like appearance; the thickness of the tooth is one-tenth of an inch, that of the plate to which it is attached one-eighth of an inch. The structure of the bony plate is open and reticulated, closely resembling in structure the base of the palatal teeth of the *Ctenodi*.

In a lecture which I delivered to the members of the Mechanics' Institution, Newcastle-on-Tyne, on 28th September, on the Fauna of the Low Main Coal-shale, I described and named the only specimen then in my possession as *Climaxodus ovatus*. To-day (October 10) I have heard that Mr. Atthey, of Gosforth, read a paper before the members of the Tyneside Naturalists' Field-club yesterday, the 9th, and described a similar tooth found by him during his long and painstaking researches in this department of palæontology. How many specimens Mr. Atthey has in his possession, or what is their state of preservation, I have not been informed.

In order to obtain reliable information respecting fish and reptile remains found in the Coal-measures, I have found it necessary to search many works, generally inaccessible to most local geologists. It has occurred to me that a popular exposition of the fishes and reptiles of the Coal-measures, with a few typical illustrations, taking each genus in its order, might prove of great service to those readers of the GEOLOGICAL MAGAZINE who have not made Carboniferous fossils a speciality, and who desire a popular exposition of the fossils that are now becoming somewhat plentifully distributed throughout the kingdom. I commend this suggestion to those of your contributors who have made the Carboniferous system a study, and who have access to the most recent specimens and works upon the subject.

IV.—THE RANGE AND DISTRIBUTION OF BRITISH FOSSIL *BRACHIOPODA*.

By J. LOGAN LOBLEY, F.G.S.

IN the following brief remarks on the range and distribution of *Brachiopoda* in British strata, and in the accompanying tables, the classification of Dr. Davidson has been mainly followed; and the calculations of the numbers have been principally based on the researches of that great authority, though the recent discoveries of Mr. C. Moore and others have been duly taken into consideration. These numbers must, of course, only be regarded as showing the present state of knowledge on the subject, as the active search which many observers are making will doubtless materially alter the figures here given.

The class *Brachiopoda* is represented in British rocks by 47 genera and sub-genera, of which a complete list is given in the following table. The generic names are arranged in the order of the incoming or earliest appearance of each genus, and the table shows the number of species of each genus in each of the great groups of British strata in which it has been found. The asterisks indicate the genera which are living in the present seas of our globe.

GENERA.	Cambrian.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Recent.
[illegible]	1	3	...	...	...	...	...	...	...	...
[illegible]	[illegible]	4	...	...	...	...	...	...	...	...
[illegible]	[illegible]	10	1	2	1	...	7	[illegible]	1	*
[illegible]	...	45–7v.	5	4	...	...	...	...	...	...
[illegible]	...	21	1	6	1	...	2	2	2	*
[illegible]	...	1	...	...	...	...	...	...	...	...
[illegible]	...	2–3v.	...	...	...	...	...	...	...	...
[illegible]	...	2	...	...	...	...	...	...	...	...
[illegible]	[illegible]	13	3	...	...	...	7	...	...	...
[illegible]	...	21	1	1	...	...	...	...	...	...
[illegible]	...	1	...	...	...	...	...	...	...	...
[illegible]	...	[illegible]	...	3	1	...	7	4	...	*
[illegible]	...	2	...	...	...	...	...	...	...	...
[illegible]	...	[illegible]	5–1v.	...	...	...	...	...	...	...
[illegible]	...	[illegible]	...	...	...	...	...	...	...	...
[illegible]	...	[illegible]	[illegible]	14	...	...	37	17–4v.	1	*
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	...	8	...	...	...
[illegible]	...	[illegible]	2	...	...	...	...	...	...	...
[illegible]	...	[illegible]	...	...	...	...	...	...	...	...
[illegible]	[illegible]	[illegible]	...	...	...	...	...	...	...	...
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	...	...	...	...
[illegible]	[illegible]	[illegible]	8	9	1	...	...	...	...	...
[illegible]	[illegible]	[illegible]	1	8	...	...	...	...	...	...
[illegible]	...	[illegible]	...	...	...	...	...	...	...	...
[illegible]	...	[illegible]	...	...	...	...	...	...	...	...
[illegible]	...	...	[illegible]	4	1	...	...	...	...	...
[illegible]	...	...	2	[illegible]	2	...	3	...	...	...
[illegible]	...	...	4	[illegible]	...	...	...	...	...	...
[illegible]	...	...	4	[illegible]	[illegible]	...	44	23	2	*
[illegible]	...	...	[illegible]	...	...	...	...	...	...	...
[illegible]	...	...	[illegible]	...	...	...	...	...	...	...
[illegible]	...	...	[illegible]	5	3	...	...	...	...	...
[illegible]	...	...	[illegible]	...	...	...	...	...	...	...
[illegible]	...	...	4	[illegible]	2	...	...	...	...	...
[illegible]	...	...	[illegible]	...	...	...	...	...	...	...
[illegible]	...	...	[illegible]	...	...	...	...	...	...	...
[illegible]	...	...	[illegible]	...	[illegible]	...	...	...	...	...
[illegible]	...	...	...	...	...	...	[illegible]	1	...	*
[illegible]	...	...	...	...	...	...	[illegible]	...	...	...
[illegible]	...	...	...	...	...	...	[illegible]	[illegible]	1	*
[illegible]	...	...	...	...	...	...	[illegible]	[illegible]	2	*
[illegible]	...	...	[illegible]	...	...	...	[illegible]	[illegible]	...	*
[illegible]	...	...	...	...	...	...	[illegible]	[illegible]	...	*
[illegible]	...	...	...	...	...	...	...	[illegible]	...	*
[illegible]	...	...	...	...	...	...	...	[illegible]	...	...
[illegible]	...	...	...	...	...	...	...	[illegible]	...	...
Magas	...	...	...	...	...	...	...	[illegible]	[illegible]	...

Of the species composing these genera and sub-genera, very few have a range extending through more than one or two formations, while several, as *Terebratula fimbria* for example, characterise a particular zone or stratum of, in some instances, not more than a few inches in thickness. The elaborate works of Dr. Davidson, however, give with so much minuteness the range of particular species that I will pass on to a brief consideration of the range and distribution of the genera and sub-genera.

The oldest of all the Brachiopods is the *Lingulella*—*L. ferruginea* having been found by Dr. Hicks in Cambrian rocks. This genus ranges through the Primordial Silurian group, giving name to the Lingula flags, in which *Lingulella Davisii* is exceedingly abundant. Above the Tremadoc slates, *Lingulella* has not, with certainty, been found. *Obolella* having recently been found in the Upper Longmynd rocks, must be placed next. This genus, like *Lingulella*, attains its maximum development in the Primordial Silurian; and dies out in the Llandeilo rocks, in which only one species has hitherto been discovered.

A *Discina* has, it is said, been also found in older rocks than any having a right to a place in the Primordial Silurian, and therefore that genus is entitled to the third place. *Discina*, however, has a much greater range than the two previously mentioned genera, since it is found in Palæozoic, Mesozoic, and in Cainozoic strata, and is, moreover, a living genus at the present day, though it has been searched for in vain in many formations both in the Palæozoic and Mesozoic groups. The greatest number of species of *Discina* have been taken from Caradoc strata, though not more than five well-marked species have been discovered in these rocks.

The very important genus *Orthis* is represented by no less than 30 species in the Caradoc rocks, but its range has not been found to extend further than from the Primordial Silurian to the Carboniferous Limestone.

Lingula, of which *Lingulella* may be termed perhaps rather a sub-genus than considered a separate genus, appears next, and has a range from the Primordial Silurian to the latest formations, and lives in the present seas of the world. It is not, however, in any formation represented by many species, and in not any of the Mesozoic or Cainozoic rocks do we find more than one species. The genus attained its maximum development in the Llandeilo rocks, in which eight species have been discovered.

Crania will be seen to have a very long range, but it is represented by very few species.

The important genus *Rhynchonella* commences in the Caradoc and ranges to the present time, *R. psittacca* being found living in the Northern seas. It is largely represented in Silurian, Devonian, Carboniferous, Oolitic, and Cretaceous rocks, but only one species has been found in Tertiary strata.

Spirifera, the next genus, has its maximum number of species in Carboniferous rocks, in which we find no fewer than 27 well-marked species. Mr. C. Moore has discovered two species in the Inferior Oolite, in which this genus appears to have died out.

Passing over several genera which have comparatively short ranges, we find the well-known *Terebratula* commencing in the Middle Devonian, having a great development in Oolitic and Cretaceous strata, and continuing to the present time.

We next find *Merista* and *Uncites* with one species each in the Middle Devonian. *Camarophoria* next, and then *Davidsonia*, of which one species only has up to the present time been discovered in British strata.

Productus has a very remarkable range and distribution. The first species we find in Middle Devonian, three in Upper, and no less than 41 in Carboniferous Limestone; after which only two species appear, and these are in the Permian Magnesian Limestone.

Stringocephalus and *Rensselaeria*, two genera with only one species to represent each, are also in the Middle Devonian.

Strophalosia we find in Upper Devonian strata, and this is the last of the Palæozoic Brachiopods.

In Mesozoic rocks, *Thecidium*, *Zellania*, *Argiope*, *Terebratulina*, and *Waldheimia* all commence in the Lias, *Terebratella* in the Great Oolite, and *Megerlia*, *Terebrirostra*, *Trigonosemus*, and *Magas* in Cretaceous formations, the last-named genus not being found lower than the Chalk; and as no genus is known to commence its range in Cainozoic strata, *Magas* may be considered, according to our present knowledge, the newest of British fossil Brachiopoda.

Eleven genera are represented by species now living in the seas of our globe, and are therefore recent as well as fossil genera. Of these *Discina*, *Lingula*, *Crania*, *Rhynchonella*, and *Terebratula*, range upwards from Palæozoic rocks.

The genera *Leptæna*, *Spirifera*, and *Spiriferina*, range from Palæozoic into Mesozoic, but do not reach Cainozoic strata, while there are no less than twelve genera, each of which is characteristic of a single formation, or minor group of strata.

The following is a list of the species of these twelve genera with the names of the formations, or groups, characterised by them. It will be seen that only two of these genera, *Orthisina* and *Orbiculoidea*, are represented by more than one species each.

Kutorgina cingulata, Bill., Primordial Silurian.
Acrotreta Nicholsoni, Dav., Llandeilo.
Orthisina ascendens, Pander }
,, *Scotica*, McCoy } Caradoc.
Orbiculoidea Beckettiana, Dav. }
,, *Forbesii*, Dav. } Wenlock.
Nucleospira pisum, Sow. sp., Wenlock.
Merista plebeia, Sow., Middle Devonian.
Uncites gryphus, Schl., Middle Devonian.
Davidsonia Verneuilii, Von Buch, Middle Devonian.
Stringocephalus Burtini, Def., Middle Devonian.
Rensselæria stringiceps, Roem, Middle Devonian.
Terebrirostra lyra, Sow., Upper Greensand.
Magas pumila, Sow., Chalk.

Thirty genera are essentially Palæozoic, and eight genera have not been found in any other than Mesozoic strata, though four of these have living representatives, while not one genus can be considered characteristic of Cainozoic strata.

Proceeding now to the consideration of the range and distribution of the nine families in which all the British fossil *Brachiopoda* may be placed, we find that nearly every family has had a long range in time, and that six are represented by recent species.

The following table shows the number of species of each family in each System or principal group of British strata.

FAMILIES.	Cambrian.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Recent.
Lingulidæ	1+1?	31+3v.	1	6	1	...	2	2	2	●
Discinidæ	?	15	1	2	1	...	7	?	1	●
Strophomenidæ.	...	81+7v.	16	9	1	...	7	......	...	...
Craniadæ........	...	7	...	3	1	...	7	4	...	●
Spiriferidæ......	...	29+5v.	41+1v.	45+1v.	5	...	8	......	...	...
Rhynchonellidæ.	...	29	18+1v.	19	3	...	37	17+4v.	1	●
Productidæ	...	3	8	48	4+3v+?	...	...	......	...	...
Terebratulidæ...	...	......	6	3+1v.	1+1v.	...	59	45+3v.	5	●
Thecididæ..... ..	...	......	...	...	...	...	14	1	...	●
CLASS— *Brachiopoda*....	1+2?	185+15v.	91+2v.	135+2v.	17+4v+?	...	141	69+7v+?	9	●

The family of *Productidæ*, represented by the *Chonetes* in the Llandovery rocks, greatly abounding in the form of *Productus* in the Carboniferous Limestone, dies out in the Permian, and is therefore a characteristically Palæozoic family.

Thecididæ, on the other hand, are characteristically Mesozoic, as they have not hitherto been found in strata older than the Middle Lias, or newer than the Chalk. We thus have one family essentially Palæozoic and one family characteristic of Mesozoic strata. Having no genus we have no family confined to Cainozoic strata, each great type of form in the Brachiopoda having come into existence long previously, the latest family being the *Thecididæ*.

Although not entirely confined to Palæozoic strata, the family of *Strophomenidæ* may almost be said to be characteristic of these rocks, since it is so largely represented in the strata below the Coal, and is only found in rocks newer than the Permian represented by a few species of one genus, *Leptæna*, found in the Lias.

Spiriferidæ, too, are very largely represented in Palæozoic strata, and very sparingly in Mesozoic, eight species only having been discovered in strata above the Permian.

The families which range from the Palæozoic rocks to the present time, and now represented by living species, are *Lingulidæ*, *Discinidæ*, *Craniadæ*, *Rhynchonellidæ*, and *Terebratulidæ*.

Of these the first, *Lingulidæ*, as we have before seen, is the oldest of all the families of *Brachiopoda*, and has been found in nearly every group of rocks from the Cambrian to the Eocene, though represented by very few species in any, the greatest number of species of *Lingulidæ* being found in the Primordial Silurian rocks, in which not more than ten well-defined species have hitherto been discovered.

If it be admitted that a *Discina* has been found in Cambrian strata, the range of the family of *Discinidæ* will be similar to that of *Lingulidæ*, since we find the genus *Discina* living in both the Atlantic and Pacific Oceans. This family is also represented by very few species in any formation, the maximum number being six in the Wenlock rocks.

The *Craniadæ* are even more sparingly represented than either the *Lingulidæ* or *Discinidæ* (there being only one genus), and they appear in a much smaller number of formations.

Rhynchonellidæ first appear in the Caradoc strata, represented by the typical genus *Rhynchonella*, and only one species. In the Llandovery strata, however, it is a much more important family; for in these rocks we find four genera and twenty species to represent it. In the Wenlock rocks the same number of genera and nineteen species have been found; but when we examine Ludlow strata, we only find two genera and seven species of *Rhynchonellidæ*. This important family is largely represented in the Devonian rocks, —the Middle Devonian especially, which has yielded three genera and eighteen species. The Upper Devonian beds do not contain more than four species, but in the Carboniferous rocks we have sixteen species. Three species have been taken from Permian rocks, above which all the generic forms except *Rhynchonella* are absent. The greatest number of genera of *Rhynchonellidæ* is to be found in the Llandovery and Wenlock rocks, but the greatest number of species in the Inferior Oolite, in which the typical genus *Rhynchonella* obtains a great development.

The family of *Terebratulidæ* is a very important one; not only from the abundance of the typical form *Terebratula* in many rocks, but also from the great number and interesting character of the genera into which the family has been divided. No less than twelve genera and sub-genera of British fossil *Brachiopoda* have been described as belonging to this family. Of these genera only three, *Terebratula*, *Stringocephalus*, and *Rensselæria*, are Palæozoic; *Stringocephalus* and *Rensselæria* being confined to the Middle Devonian, in which also the typical form *Terebratula* first makes its appearance. Six genera, *Terebratula*, *Zellania*, *Waldheimia*, *Terebratella*, *Terebratulina*, and *Argiope* appear in the Lower Mesozoic rocks, the greater number of generic forms of *Terebratulidæ* being found in Cretaceous strata; and in these rocks no less than nine genera have been discovered. We thus have the greatest number of genera of *Terebratulidæ* in Cretaceous rocks; but the greatest number of species in the Inferior Oolite, in which twenty-two species have been found. *Terebratulidæ* is very weakly represented in Cainozoic strata; *Terebratula*, *Terebratulina*, and *Argiope*, only having been discovered. These genera, with three others, *Terebratella*, *Waldheimia*, and *Megerlia*, existing in the present seas,

When we consider the range, distribution, increment, decrement and maximum development of the class without reference to its separate genera or families, we find that the class *Brachiopoda* is represented in British strata by a very large number of species, some of which are found in almost every geological formation. Coming into existence, as far as we yet know, in Cambrian times, *Brachiopoda* abounded in Silurian seas, but the class attained its maximum development in the Carboniferous period. A small number of species have been taken from Permian rocks, but Triassic strata have not hitherto yielded us any. When we examine Liassic and Oolitic strata, we find again a large number of species, which, however, become fewer as we ascend the scale, until we reach the Portland rocks, in which no Brachiopod has been discovered. The class again increases in importance in Cretaceous strata, and again diminishes in Tertiary formations, which have hitherto furnished us with not more than eight or nine species. Of living *Brachiopoda* seventy species have been described; these have a wide geographical range, and have been found both in littoral waters and in seas of great depth.

Although in British seas Brachiopods are very rare, yet they are by no means so in the seas of Southern latitudes, the bays and harbours of Australia swarming with *Waldheimia* and other forms of this interesting and remarkable class of the animal kingdom.

V.—On the Classification of Rocks.

By Capt. F. W. Hutton, F.G.S.

No one, I think, will deny that geology is far behind all the other sciences in the classification of those substances which form its special study, viz., rocks. No two authors agree on the subject, and no one seems to have attempted to form a scientific classification, based on a natural system.

The reason perhaps is, that nearly all the classifications we have are from the hands of chemists and mineralogists rather than geologists; and no geologist, therefore, can admit their systems as natural, or as adapted to his purpose. How, for instance, could a geologist think of classifying an aphanite-slate, interbedded with quartzite and clay-slate, with an aphanite dyke cutting across the rocks in an uncertain direction? It is absolutely essential for him to determine to which class the piece of aphanite he may just have broken off with his hammer belongs, as it will make a vast difference in the structure of the country he is examining, and in the geological map of the district. Cotta, indeed, says that "we cannot lay down a logically complete system of classification, to embrace all rocks, on any principle." In this I quite agree with him; but any one principle means an artificial classification, and I believe that it is quite possible to form a natural system complete enough to answer all the wants of a geologist, and I hope that I shall not be considered presumptuous for having, with this view, drawn out the following table, in which I have tried to make the rocks fall into as natural groups as possible. That I have not succeeded in all cases I am the first to admit, but I hope that it will not be without its use in showing what appears to me to be the most natural system that we can adopt at present.

In drawing up this table I have tried to base the different divisions, etc., on facts well established, and not on debated theoretical points. This has led me to reject, after much consideration, some names in common use, such as "Igneous," "Intrusive," etc., and to substitute others which, I hope, will not be open to the same objection. The usual mode of making the Metamorphic, Plutonic, and Volcanic rocks form separate classes is, in my opinion, highly artificial, as it separates widely many rocks closely connected both chemically and geologically. I have therefore used these terms to separate only the sections chemically related into allied groups, and have taken the original formation of the rocks themselves as the basis for dividing them into the larger classes and divisions.

I prefer the terms "subærial" and "subaqueous" to "aerial" and "aqueous," as they better describe the position of the rock when being formed, and the complimentary term "subterranean" implies no theory; so that although some geologists might maintain that granite is an aqueous rock, none would insist upon its being "subaqueous," or produced *in its present form* under water; and I also think that none will be inclined to deny that the rocks in the "subterranean" class have received their final form, in which we now see them, below the earth. It may, indeed, be objected that the Volcanic groups were solidified, and therefore formed above the earth; but, to my mind, these rocks were chemically formed in the Volcano, and the fact of their having cooled on the surface as lava, or below the earth as dykes, makes no essential difference, although it may constitute varieties. The case is quite different with the ejected tuffs and tufas. When they were below the earth they were lavas, and it was not until they were ejected, and mixed with other substances, that they became tuffs.

The division of the subærial class that I have called "conflated" is a very important one in many parts of the world, and ought not by any means to be omitted. Here, for instance, in New Zealand, it sometimes forms hills 500 and 600 feet high, rudely stratified, and bound together with hard ferruginous cement, and often displaying beautiful examples of cross bedding.

In the "Ejected" and "Tufaceous" divisions it will be noticed that I have confined the word "tuff" to subærial accumulations, and "Tufa" to subaqueous ones. Geologically this distinction is important, for besides the different relations of land to water that they show, tuffs always mark the site of a volcano, while tufas may be found many miles distant from the point of eruption. I should consider the mud streams that sometimes run down the sides of a volcano as a variety of tuff.

The metamorphic groups of the Tufaceous division may be open to objection as too theoretical, but if we allow volcanic action to have taken place during Palæozoic times, tufas must have been formed, and some must now exist in a metamorphosed condition; so that supposing it shown that some of the rocks placed in these groups had not a tufaceous origin, still the error would be in the arrangement of the rocks in the system and not in the system itself. The tufaceous rocks are, no doubt, nearly as much entitled to the name "ejected" as the subærial tuffs, but I have thought it better that each of the divisions should have a distinct name, and the rocks belonging to the tufaceous division are often mixed with sand, etc., and so are not altogether ejected.

The "Chemico-organic" division wants more alteration than any of the others, and might, perhaps, be split up into sub-sections and sub-groups with advantage. I have, however, kept them all together, for at present it is impossible to say with certainty whether some of the members owe their origin to organic or chemical causes; and they form on the whole a very natural group.

Of the "Detrital" rocks little need be said. I have placed the Conglomerates and Breccias in a section by themselves, for although they are often very different chemically, they are always the proof of peculiar geological conditions having existed when they were formed.

The "Subterranean" rocks I have separated into two divisions that have a very important geological distinction. The "Fundamental" rocks are those that have been metamorphosed, or, at any rate, have assumed their present appearance, in the place where they were originally formed, so that they generally occupy large districts; while the "Migrated" rocks are those that have been forced from the position in which they were first formed, and are now seen, either as dykes or lava streams, only in isolated patches.

It will be noticed that some rocks occur in two places in the table. This is owing to rocks that we now call under one name having had two different origins. All stratified felstones, a not uncommon rock in some districts, I look upon as metamorphosed trachytic tufas, while felstone dykes could not have been thus formed; and although both rocks may have the same chemical composition, they should still have different names. The same may be said with respect to that geological sphinx—Serpentine. The behaviour of massive serpentine is so different from that found in dykes, that in a geological classification they must be separated.

It may be asked why have I removed Clay-slate so far from Mica-schist and its associated rocks? and why should not Gneiss be classed as a metamorphosed sandstone equally as much as Quartzite? My answer is that the sub-aqueous origin of Clay-slate, Phyllite, Quartzite, and Granular limestone is quite apparent, while that of Gneiss, Mica-schist, etc., is not so; and that the schists are constantly associated together, while the others are often interbedded with only hemimetamorphic rocks and could not be considered as fundamental; whilst, on the other hand, to place Gneiss, Mica-schist, etc., among the metamorphic Detrital rocks would be to admit a theory and to break up a geologically natural group; for if we admit Gneiss among the Detrital rocks why not granite also?

It may also be objected that this arrangement separates too widely the lavas from the mechanically formed accompaniments of volcanic eruptions. If, however, we consider the series as circular and not linear, they will be placed in as close juxtaposition as possible, considering the very different aspect and mode of formation of the two.

Many other objections will no doubt be pointed out, but I think that enough has been said to explain the principles on which this classification of rocks is based; and I do not wish it to be supposed for a moment that I think that I have completed so difficult a task;

my only hope is that I may have suggested the way in which s order may be introduced into a subject which is at present, a imagine, in a great state of confusion.

Class	Division	Section	Group	Kind
Subaerial	1. Conflated	....	......	Blown Sand.
	2. Ejected ..	Acidic	......	Pumice-tuff; Trachyte-tuff.
		Basic	......	Basalt-tuff.
Subaqueous	3. Tufaceous	Acidic.........	P.[1]	Pumice-tufa, Trachyte-tufa, Tr breccia, and Agglomerate.
			H.[2]	Felsite-tufa.
			M.[3]	Some Felstones, and Clay-stones chyte Porphyry.
		Basic	P.	Dolerite-tufa; Basalt-breccia a glomerate.
			H.	Greenstone-ash, Palagonite-tufa.
			M.	Diorite Sandstone and Slate, A Slate, Schalstein.
	4. Chemico-organic...	Calcareous...	P.	Earthy Limestone, Chalk, Ma Limestone, Gypsum, Rock S
			H.	Compact Limestone, Dolomite, drite.
			M.	Granular Limestone. Ophical Verde-antique.
		Siliceous ...	P.	Diatomaceous Earth.
			H.	Tripoli.
			M.	Some Hornstones and Lydiansto
		Carbonaceous	P.	Peat, Lignite.
			H.	Cannel Coal, Coal.
			M.	Anthracite, Graphite.
		Ferruginous	P.	Bog-iron ore.
			H.	Brown Hydrated Hematite (some
			M.	Red Hematite (some).
	5. Detrital...	Siliceous ...	P.	Sandstone, Gritstone.
			H.	Quartzite.
			M.	Jasper-rock, Itacolumite, Novacu
		Conglomeritic	P.	Gravels and Boulder-beds, etc.
			H.	Conglomerates and Breccias.
			M.	Some Porphyrics.
		Argillaceous	P.	Clay, Shale, Marls.
			H.	Clay-slate, Clay-rock.
			M.	Argillite or Phyllite, some Horn
Subterranean	6. Fundamental ...	Acidic	S.[4]	Gneiss, Mica-schist, Quartz-schi nulite, Schorl-rock.
			Mas.[5]	Granite, Greissen.
		Basic	S.	Hornblende-schist, Chlorite-schis schist, Eklogite.
			Mas.	Syenite, Minette, some Serpentin
	7. Migrated	Acidic	T.[6]	Felstone, Quartz-porphyry, Pit Eurite, Elvanite.
			V.[7]	Rhyolite, Trachyte, Phonolite, A Perlite.
		Basic	T.	Diorite, Aphanite, Diabase, (Lherzolite, Melaphyre, Opioli pentine).
			V.	Dolerite, Basalt, Anamesite.

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[1] P. = Protomorphic. [2] H. = Hemimetamorphic. [3] M. = Metamorphic. [4] S. = S
[5] Mas. = Massive. [6] T. = Trappean. [7] V. = Volcanic.

NOTICES OF MEMOIRS.

I.—On the Hypothesis of the Internal Fluidity of the Terrestrial Globe.

By M. Delaunay, Académie des Sciences, Séance du 13 Juillet 1868.

[Communicated by David Forbes, F.R.S., &c.]

A PROFOUND study of the several circumstances of the form, composition, and temperature of the materials which constitute the surface of the terrestrial globe leads to the admission that its interior possesses a high temperature, and, consequently, that the different substances of which it is composed are in great part in a state of fusion, so that the globe itself is essentially a liquid mass covered by a solid crust of but little thickness when compared with its diameter.

A formidable objection to this opinion was brought forward nearly thirty years ago by Mr. Hopkins in a series of memoirs inserted in the Philosophical Transactions of the Royal Society of London for the years 1839, 1840, and 1842. This objection, which is based upon the consideration of two astronomical phenomena, the precession and nutation, is as follows:—It is well known that the precession and nutation taken conjointly consist in a change of direction experienced by the axis of rotation of the earth. Without the precession and nutation, the axis of the earth would always remain parallel to itself, and if prolonged would always pierce the celestial dome in exactly the same point, at least if the dimensions of the earth's orbit be disregarded when compared with the distance which separates it from the stars.

In consequence, however, of the precession and nutation, the earth's axis becomes more and more inclined from the direction it previously possessed; the point in which it pierces the celestial dome, to which the name of the Pole is given, displaces itself slowly and by degrees amongst the stars, the precession causing it to describe a circle parallel to the ecliptic, whilst the nutation causes it to move in a very small ellipse, having for centre the position which it would have occupied if influenced by the precession alone.

This continual change in the direction of the earth's axis of rotation has been connected in a most happy manner with the grand law of universal gravitation,—Newton having demonstrated that the movement of precession follows as a consequence of the flattening of the earth.

The attraction which the sun exercises on the entire mass of the terrestrial globe would have no influence whatever on the rotary motion of the globe round its centre if the globe itself were spherical and homogeneous, or if it were made up of concentric and homogeneous spherical layers.

In consequence, however, of the swelling out of the globe along the equator this is not the case: the action of the sun upon the sort of pad formed by this equatorial swelling, causes little by little, a

[illegible]

[illegible] brought by Mr. H[illegible] was adopted [illegible] in his memoir on the Rigidity of the Earth [illegible] p. [illegible], where he introduces it as follows.

"1. That the earth cannot, as many geologists suppose, be a liquid mass enclosed in only a thin shell of solidified matter, is demonstrated by the phenomena of precession and nutation. Mr. Hopkins, to whom is due the grand idea of thus learning the physical condition of the interior from phenomena of rotatory motion presented by the surface, applied mathematical analysis to investigate the rotation of rigid ellipsoidal shells enclosing liquids, and arrived at the conclusion that the solid crust of the earth must be not less than 800 to 1000 miles thick. Although the mathematical part of the investigation might be objected to, I have not been able to perceive any force in the arguments by which this conclusion has been controverted, and I am happy to find my opinion in this respect confirmed by so eminent an authority as Archdeacon Pratt (Figure of the Earth, 1860, § 86.) 2. It has always appeared to me, indeed, that Mr. Hopkins might have pressed his argument further, and have concluded that no continous liquid vesicle at all approaching to the dimensions of a spheroid 6000 miles in diameter can possibly exist in the earth's interior without rendering the phenomena of precession and nutation sensibly different from what they are."

Thus it will be perceived that the objection brought forward by Mr. Hopkins against the ideas generally accepted by geologists as to the interior fluidity of the terrestrial globe, has been regarded by many learned Englishmen as perfectly established.

I am of an opinion diametrically opposed, and I believe that this conclusion of Mr. Hopkins is not based on any true foundation whatever. This is what I propose to explain to the Academy in all brevity.

When we apply the theories of rational mechanics to the study of natural phenomena, we immediately find that we have to deal with problems of the greatest complication. If we attempt to consider these questions with full rigour, it is impossible to succeed, for reasons which do not even require enumerating. We are obliged, therefore, to rest contented after resolving, not the problems themselves at which we aim, but other questions more or less bearing upon them, which in themselves present a degree of simplicity sufficient to enable us to arrive at some more or less rigorously correct solution.

It is thus that we are led to substitute the study of solids of absolutely invariable form, for that of those which actually are met with in nature; thus also we are accustomed to attribute to liquids the property of absolute fluidity, which in nature never exists, etc.

It becomes necessary, therefore, to place ourselves as it were side by side with the reality, and to remember always, that the results which we may have arrived at, may be vastly modified by circumstances which we may have neglected to take into account.

In order to concentrate our ideas on the subject, let us take a spherical vessel, a glass globe for example, filled with a liquid, say with water: if now we admit that the liquid is endowed with an *absolute fluidity*, and we impart to the globe a sudden movement of rotation round its central vertical axis, the globe should alone turn without at all carrying along with it the liquid which it contains, which ought to retain its pristine immobility.

This is easily verified by imparting a more or less rapid rotary motion to the globe; light substances floating on or suspended in the water will not appear to change place, notwithstanding the motion given to the globe. But will this always be the case, whatever be the rapidity of the motion given to the globe? Can we admit that the liquid will remain indifferent to the motion of the envelope which contains it should we revolve the globe very slowly?

In admitting the *absolute fluidity* of the liquid we forget to take into account its *viscidity*. Although this viscidity is extremely feeble in most fluids with which we are acquainted, it is never altogether wanting, and this explains why, provided that the rotary movement communicated to the globe be sufficiently slow, the liquid is carried round along with the globe itself, the whole revolving together just as if the liquid had been frozen, and along with its envelope formed one entirely solid body.

Let us return to the terrestrial globe, and let us admit with the geologists that it is composed of a liquid mass covered by a thin solid crust. If the disturbing actions which produce the precession and nutation did not exist, the entire globe, both the solid envelope and its enclosed liquid, would revolve together as one, round the poles whose direction would remain constant in space.

Even if it is advanced, that at some particular epoch a difference might have existed between the rate of movement of the crust and of the liquid interior, the resulting friction must gradually have destroyed this difference and brought about a conformity in the motion of both parts.

The disturbing forces which give rise to the precession and nutation act upon the solid crust and tend to make it revolve round an axis, which deviates more and more from the direction of the axis round which it at first rotated; the rotary motion imparted to the solid crust by these actions is one of extreme slowness, and has to unite itself with the movement of rotation which it already possesses.

The question then is, whether the internal liquid mass participates in this additional movement, or is the solid crust alone affected by it without immediately carrying the liquid along with it. In my opinion there cannot be the least doubt as to what the reply must be, for the additional motion due to the before-mentioned causes is of such slowness that the fluid mass which constitutes the interior of the globe must follow along with the crust which confines it, exactly as if the whole formed one solid mass throughout.

The pressure to which the liquid mass which we suppose to exist in the interior of the earth is subjected to, is so enormous, that we cannot even form an idea of the influence which it may exert on the degree of viscidity of the fluid in question. But even if the fluid matter is present under conditions identical with those of the liquids which we see around us, this would suffice to cause the results to be such as we have already explained.

At the same time that I was perfectly convinced of the correctness of these views, I resolved nevertheless to confirm them by direct experiment. At my request, therefore, M. Champagneur, attached to the Philosophical Laboratory of the Sorbonne, has arranged a simple and complete experimental demonstration which removes every possible doubt on the subject.

I content myself at present with merely alluding to this experiment, as I leave it to that gentleman to make the Academy acquainted with its details.

After the preceding observations, it appears to me impossible to admit that the effect of the disturbing forces, to which the precession and nutation are due, only extend over a portion of the terrestrial globe: the entire mass, on the contrary, must be influenced by these disturbing forces, whatever may be the supposed magnitude of its fluid interior, and consequently it follows that the phenomena of precession and nutation cannot furnish us with any data whatsoever relative to the greater or less thickness of the solid external crust of the globe.

[In directing the attention of our readers to this most important communication, which so thoroughly explains away the objections lately brought forward by mathematicians and astronomers, against the so-long accepted theory of the internal fluidity of the earth, we would express our entire concurrence in the remarks made by M. D'Archiac in the discussion of this paper, in which he expressed his lively satisfaction at seeing the subject thus ably investigated by an authority so doubly eminent both as an astronomer and mathematician as M. Delaunay. Further observations upon this interesting question will be found in a recent paper by Mr. David Forbes in the Chemical News of October 14, vol. xviii. p. 191, to which we also would refer.—ED. GEOL. MAG.]

II.—ON THE FORMATION OF MOUNTAIN CHAINS.

By N. S. SHALER, Esq.[1]

NOTHING shows more clearly the imperfect nature of our knowledge of the forces which have brought about the existing condition of the earth's surface than the doubt which still exists as to the cause of mountain chains. There have been many views brought forward, some of which seemed to satisfy most of the facts, but none have been sufficiently broad to include all the phenomena, and the most clearly-defined result of the action of physical forces of the earth's crust still remains involved in obscurity. The main difficulty in the way of gaining an insight into the cause of all the dynamical phenomena of the earth's surface, is the doubt which has all along existed as to the physical condition of the mass of the earth. Until it is decided whether the sphere is rigid to the centre, or essentially fluid, with a crust floating upon its surface, it will scarcely be possible to attain to anything like certainty in our explanations of all the movements in the crust. Although in deference to the weight of opposing opinion, we must regard the question of fluidity or rigidity of the interior as still unsettled, there can remain little doubt in the minds of those geologists whose views are in no way influenced by the defence of long held opinions, that the earth is essentially rigid, and that the condition of mobility of the elements of the mass which perfect fusion gives, can not be the prevailing condition of the interior. The calculations of Hopkins[2] and Thomson[3] seem to make scarcely any other view possible, and the few investigations which have been made into the contraction of the igneous rocks, in cooling, make it impossible to conceive how a solid crust formed on a fluid interior could be sustained, subjected as it has been to innumerable shocks, sufficient to rupture it, and sink the fragments in the fluid below. Against

[1] From the Proceedings of the Boston Society of Natural History, June 6, 1866.

[2] Hopkins (Wm.) Phil. Trans. of the Royal Soc., 1836, p. 382.

[3] Thomson (W.) on the Rigidity of the Earth. Proceedings of the Royal Soc., Vol. xii. p. 103.

these facts we have to set those evidences of igneous action afforded by volcanoes and associated phenomena, and which have, not without reason, been supposed to give trustworthy evidence of a generally fluid condition of the interior. Fairly weighed, however, all that can be considered as proven by all the evidences we have is, that in that portion of the past history of the earth of which we have record, there has existed a condition of igneous fluidity beneath a large part, if not the whole extent, of the surface. That this igneous fluidity extends to the centre, or even that it is of more than a very few miles in depth, are suppositions which derive no valid support from igneous phenomena. The increase of temperature as we go from the surface towards the centre, and the extreme elevation of heat which must exist at considerable depths, can not be regarded as evidence of the general fluidity, until it has been shown that the internal pressure has not a greater influence in preventing liquefaction, than internal heat in producing that condition. In the present state of knowledge, or rather ignorance, of the physical questions involved in this problem, the safest position is that which conflicts least with the conclusions derived from the cognate sciences of astronomy and physics. The former science protests that certain observed facts could not exist if the mass of the earth was essentially fluid, and that tried by tests far more unerring than any the geologist is able to apply, the conclusion is reached that our planet is at least as rigid as glass, and probably as rigid as steel. From the physicist we hear that all the known materials which have come to us from the earth's interior, contract in cooling, and that the general internal fluidity would cause any crust to shatter to pieces and fall in fragments into the fluid below, as soon as it had attained any such thickness as we know the crust to have. If we attach to these calculations the importance they deserve, we are forced to admit that the idea of the igneous fluidity of the interior is quite untenable.

A much more satisfactory view than that just referred to, which will not conflict with the results of investigations in the exact sciences, may be obtained by a brief consideration of the possible conditions of solidification of the cooling earth. If the effect of pressure in promoting solidification at the earth's centre were greater than the effect of heat in resisting solidification, then the mass would congeal first at the centre, and solidification extend thence towards the surface. If, on the other hand, the effect of the pressure at the centre failed to overcome the tendency to liquefaction induced by the extreme heat of that point, then we must suppose that cooling went on until the whole mass was reduced to something like an equal temperature throughout, and the whole sphere became solid at once. During this process of cooling down, successive crusts might be formed, but they would necessarily be transient phenomena, breaking to pieces as soon as they began to attain considerable thickness.[1]

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[1] See the Preliminary Observations to the paper of Hopkins above referred to, where these considerations will be found.

This last supposition seems to be excluded by the well-known fact of the increase of temperature as we go from the surface towards the centre; the rate of increase is such that we would attain a temperature sufficient to melt the most refractory substances in a few miles from the surface; this is far from the state of things we would expect to find if the whole interior had been reduced to the temperature at which solidification could take place at the surface before any part became rigid. On this account we are driven to adopt the other view as the more probable, and regard the superficial portions as the last to become solid, and the centre as the first rigid portion of the earth.

As solidification advanced from the centre towards the surface, there would be a time when the remaining liquid matter was of inconsiderable thickness, that the surface might also begin to solidify, and the intervening igneous matter being in a state of viscous fluidity, might so far uphold the solid outer crust, that it would not break up and fall into the fluid below. The further solidification of the interior would then take place in two directions outward from the central nucleus, and inward from the outer crust. If, however, this residual fluid matter was confined, beneath, say, one hundred miles of crust, cooling would proceed with such extreme slowness, that a very great time might elapse before it became lost in the already solidified surfaces above and below. It is not impossible that to this insignificant relic of an original molten condition, we owe all the phenomena of igneous action which have affected the crust since the beginning of the geological record.

There seems no point of conflict between this conception and those conclusions of geologists which are supported by any considerable amount of evidence; it only contravenes those hypotheses which have failed when subjected to critical examination, or which from their essentially undemonstrable character can not be either verified or disproven. At first sight it might seem difficult to account for the phenomena of corrugation of the earth's crust, as exhibited in the continental folds, and in mountain chains, if we reject the hypothesis of internal fluidity. The design of the present paper is to show some reasons for believing that both of these phenomena may be explained without the assumption of anything more than the trifling amount of igneous fluidity involved in the hypotheses we have just discussed.

Without any particular examination of the facts, it seems to have been assumed by most geologists that all the phenomena of corrugation, whether exhibited in mountain ranges, or in continents, are to be regarded as effects of one and the same cause, differing only in magnitude. It is manifest that it is a matter of first importance in seeking an explanation of the origin of these phenomena, to determine whether this assumed identity of cause is true or no. If it be the fact that continental elevations and mountain elevations are but degrees of effect of the same cause, then there should be no other differences in the phenomena than those of magnitude, or of features dependent directly upon the magnitude of the areas involved in the disturbance; furthermore there should be something like a series, at one extremity of which could be placed the greatest relief of continental fold and oceanic depression, and passing gradually to the most inconsiderable flexures. It requires no very careful examination to bring the observer to the conviction that those essential features do not exist. The phenomena observable in the two actions are not cognate. There can hardly be said to be anything like a series or gradation connecting the whole assemblage of phenomena, and the inference seems strong that the cause is not the same in the two cases. We find, for instance, in continental folds, broad curves of the surface, which narrow without exception towards the south, and which exhibit in no part of their structure the evidences of powerful lateral thrust, which are the most conspicuous phenomena of mountain chains. In these latter, however, we perceive evidences of linear disruption of the crust, showing intense, but localized energy, with no tendency to increase of magnitude in any one direction. In the continents we behold curves of thousands of miles in diameter, showing an equal force acting throughout, in the mountain very powerful forces acting along one line, and inoperative a few tens of miles away. There seems nothing in common in the phenomena except that both are folds of the earth's surface. The great breadth, and comparatively gentle curves, characterising the continental folds, show that a great thickness of material is involved in the movement; their gradual development in successive geological periods, together with what we know concerning the loss of heat from the interior of the earth renders it eminently probable that they arise from the accommodation of a hardened outer crust to a diminished nucleus. All the fluidity required in this view of the effect of the contraction of the mass upon the contour of the crust, is given by the hypothesis which claims that solidification began at the centre, and that all that remains in any sense liquid, is a very small portion comparatively near the surface.

While the contour of the continental folds, as exhibited both in land surface and sea floors, evinces the gradual operation of the general contraction of the earth on a crust of great thickness, we have in mountain chains another effect of contraction, which cannot, from the evidence, be properly referred to the shrinking of the whole mass. It is evident that if the continental folds are compensative wrinkles formed in the adaptation of a crust to a diminished nucleus, the mountain chains can not be of the same nature; it is not to be believed that a crust would bend from the action of the same force into the broad, low curves of the continents, and into the sharp defined and narrow fractures of a mountain range.

Accepting, as established, the fact that mountain chains are the result of lateral pressure, and indirectly of contraction from loss of heat, and denying that they are the result of the accommodation of the crust to the nucleus, it is at once manifest that we must seek their origin in the changes going on within the crust itself, and in no way connected with the regions below. And within that crust we can find forces operating to produce contraction quite sufficient to account for all the facts.

According to the computations of Thomson,[1] we may assume that at the close of ten thousand years after solidification of the surface of the earth had taken place, the rate of increase in temperature would be 2° Fahrenheit for each foot of descent, and with the lapse of time the rate of increase in going towards the centre would be less and less rapid in about the proportion indicated in the table below.

10,000	years after	freezing of surface,	2° Fahr.	for each	foot.[2]
40,000	”	”	1	”	”
160,000	”	”	$\frac{1}{2}$	”	”
4,000,000	”	”	$\frac{1}{10}$	”	”
100,000,000	”	”	$\frac{1}{50}$	”	”

If this calculation is correct, (and that it is in a general way correct, does not seem to admit of much doubt, provided we accept the hypothesis of original igneous fluidity,) it follows that the gradual cooling of the deeper portions of the crust must result in the formation of a strong lateral pressure at every point near the surface. The truth of this proposition is readily seen, when we consider that while the original surface, which in ten thousand years after the hardening of the crust had been reduced to the temperature of the atmosphere, retained the same temperature in the ages which followed, the portions of the crust beneath were constantly parting with their heat, and approaching nearer to the thermal condition of the surface. There would be no shrinkage of the surface layer from the loss of heat, while from this cause the contraction of the deeper portions would be considerable. This would give precisely the conditions requisite to produce a rending and upfolding of the superficial strata of the outer shell. Immediately after the formation of a crust, the progressive diminution of the interior heat would begin to produce a tension on the surface, which would augment as the ceaseless flow of heat went on, until either a rupture of the contracting beds, or the folding together of the superficial layers, relieved the strain. Both these methods of accomplishing the movement of contraction, have been most probably operative at different times and places in the earth's history. Furthermore, as the upper portions of the crust, or region of slight contraction, is of much less thickness than the region which, by its considerable contraction, produced the tension, we

[1] Thomson (Wm.) on the Secular Cooling of the Earth. Trans. Roy. Soc. Edinburgh, xxxiii. sec. 1.

[2] The effect of these changes in temperature may be estimated from the following table of the expansion of various substances under the influence of heat:

For each degree of Fahrenheit,

Granite	expands about	000004825
Marble	” ”	000005662
Sandstone	” ”	000009532

A stratum of granite five hundred miles in diameter would contract, on passing from a temperature of 3,000 degrees Fahrenheit to the average temperature of the earth, about seven and a half miles; in the case of a sandstone area of the same diameter, the contraction would amount to about fifteen miles.

The computations on which these estimates are founded were based on experiments made by Mr. H. C. Bartlett, of the United States Engineers, and published in the Amer. Jour. Science, vol. xxii. p. 136. See also for other data on this point Ninth Bridgewater Treatise, C. Babbage, 2nd edit. Appendix, p. 221.

would expect the fracture to take place on the surface, rather than below. There is one thing which could operate to prevent the certain contortion of the superficial portions of the crust, and that is the horizontal position of its beds; as ordinarily constituted, the resistance which the upper few miles of the crust could oppose to the action of any force tending to throw it into folds, is very great. When the contortion has once begun, and this resistance fairly overcome, all further changes would meet with comparatively little resistance.

We have spoken only of those cases where the original surface had continued to exist from the beginning, while the isogeothermals beneath them had gradually sunk deeper and deeper towards the centre of the earth. This being a very unlikely condition, it remains to be seen what would be the effect where the actions of denudation, or deposition, are going on. It is evident that whenever the rate of denudation was such that the removal of the crust took place with the same rapidity as the recession of the isogeothermals from the surface, there could be no lateral strain produced by the loss of heat. Where, on the other hand, rapid deposition of materials was taking place, and the isogeothermals, on that account, were rising towards the surface, there would also be no such strain on the upper part of the crust. It thus appears that the conditions of tension competent to produce mountain chains, would only be found strongly developed in regions where the rate of denudation was less than the rate of recession of the isogeothermal lines, or where the rate of deposition was not sufficiently rapid to prevent the recession of the lines of equal heat.

Accepting this hypothesis of the origin of mountain chains, it is at once seen that they should have their region of greatest development on the land surfaces, and seldom or never originate on the ocean floors. On the land areas we would expect to find them originating at those points where there were some forces operating to favour the displacement of the beds constituting the crust, from their normal position, for at such points the contracting force would most easily produce corrugations. The author has elsewhere given a brief notice of a view of the origin of continents, from the tendency of all regions where deposition is going on, viz., sea bottoms, to subside.[1] This view, if correct, will warrant us in believing that shore lines are points where fracture and dislocation of the crust are likely to occur. The distribution of volcanic vents of the present day, and the instructive fact that volcanic outlets of former geological periods ceased to be active when left inland, in the progress of geological changes, would of themselves indicate a peculiar liability to rupture of the superficial portions of the crust along shore lines. Let us suppose that the recession of the isogeothermal lines had placed the superficial portion of the crust in a state of tension, which could only be relieved by the formation of mountain elevations, and that the laying down of sedimentary materials had, at the same time, prepared that portion of the crust beneath the ocean floor for subsi-

[1] See these Proceedings, Vol. x. p. 237.

dence, then the moment this latter action is effected, it is likely to bring about fractures along shore lines, attended by the escape of gaseous and igneous materials. This dislocation of the crust would be attended by the pushing together of the superficial portions from either side, and the resulting elevations might be complicated by the intrusion of a greater or less amount of igneous matter.

This view of the origin of mountain chains seems to be reconcilable with some of the most prominent features which are to be found in their structure and distribution. Their usual, if not invariable, origin along shore lines, the suddenness of their formation, the variable amount of igneous action exhibited in their masses, are explicable on this hypothesis. On the other hand it is not to be denied that some considerable objections can be urged against it. In the first place, in order that any considerable elevation be formed by this action, it would be necessary to have the upper and lower beds slide one upon another, to a certain extent; but it is to be borne in mind that the power we are hypothecating is practically illimitable, since it would, by the supposition, continue to accumulate until the force became sufficiently great to overcome resistance. The sliding of beds upon each other under the influence of great lateral pressure, from the contraction of the lower portions of the crust, has fewer objections to be urged against it than the view which assigns the origin of mountain chains to the passage of great waves of translation through the crust, and their fixation by the intrusion of molten matter.

It is scarcely necessary for the author to state that no claim whatever is meant to be made in this paper to the hypothesis of the origin of the features of corrugation of the crust from the influence of contraction from loss of heat, one of the oldest and most generally accepted theories of the science. It having been denied by very high authority that there existed any cause competent to produce lateral thrust, and thus to originate mountain chains, it has seemed desirable to direct attention to the fact that the recession of the isogeothermals would be attended by such lateral strain.

The points which have been suggested in the foregoing consideration, may be briefly summed up as follows:

1. That the most probable hypothesis in the present state of our knowledge of the earth, is, that it consists of an immense solid nucleus, a hardened outer crust, and an intermediate region of comparatively slight depth, in an imperfect state of igneous fusion.
2. That the continental folds are probably corrugations of the whole thickness of the crust.
3. That mountain chains are only folds of the outer portion of the crust caused by the contraction of the lower regions of the outer shell.
4. That the subsidence of ocean floors would, by producing fractures and dislocations along shore lines, tend to originate mountain chains along sea borders, and approximately parallel to them.

[In connection with this subject, see also paper by the Rev. O. Fisher, *ante*, p. 493; also Delaunay, *ante*, p. 507.]

REVIEWS.

I.—Description des Roches composant L'Ecorce Terrestre, et de Terrains Crystallins constituant le sol primitif, ouvrage rédigé d'aprè la classification, les manuscrits inédits, et les leçons publiques de feu P. L. A. Cordier par C. D'Orbigny. Paris, 1868.

M. D'ORBIGNY has rendered a useful service to geology by publishing a detailed classification and description of Rocks by the late Professor Cordier, who for more than thirty years of his long scientific career, has studied with extreme care, both in the field and the cabinet, the composition, origin, position, and other character of the rocks which constitute the crust of the globe. M. Cordier's collection comprised more than 10,000 varieties of rocks, chosen with special care, and classed according to his own method, which is based on the physical, chemical, mineralogical, and geological characters that rocks present, giving prominence to that of composition. This collection is now arranged in the Museum of Natural History of Paris, and the work before us embodies the classification of rocks as defined by M. Cordier, who unfortunately during his lifetime published no treatise on the subject, with the exception of an important memoir "on the mineral substances which enter into the composition of volcanic rocks of all ages," in the *Journal de Physique* for 1815–16, so that the only knowledge to be obtained of his system was from those who were fortunate enough to attend his courses of lectures. His colleague, M. C. D'Orbigny, published in the *Dictionnaire universel de histoire naturelle* (article *Roches*), 1848, a succinct description of rocks from notes taken at the lectures of M. Cordier. The present volume is an enlarged and considerably improved edition of this article, embodying not only the public lectures, but the manuscripts left by M. Cordier, as well as a careful examination of the collection itself. The first part contains the distinctive characters, specification, and classification of rocks; the second part comprises their detailed description, synonymy, position, and industrial uses, and the third part includes an hitherto unpublished manuscript "on the structure of the terrestrial crust, and a description of the primordial rocks," as well as the memoir on volcanic rocks above mentioned.

The fundamental principle of the classification is that of *composition*. Three great divisions are established. 1. Normal rocks, including rocks proper; 2. Abnormal, mineral veins and irregular deposits in caverns, etc.; 3. Meteoric rocks.

The normal rocks are divided into four classes.

Class I. Roches a base de Silicates. *Families*, Felspathic, Pyroxenic, Amphibolic, Epidotic, Grenatic, Diallagic, Talcose, Micaceous, Quartzose, Vitreous, Argillaceous.

Class II. Roches a base Acidéfère. *Families*, Calcareous, Rock Salt, Gypseous, Alunitic.

Class III. Roches a base métallique. *Families*, Carbonate, Hydrate, and Peroxide of iron, Silicate of iron, Oxydulous iron, Manganese, Iron pyrites.

Class IV. Roches a base combustible. *Families*, Sulphur, Dysodile, Asphaltum, Graphite, Anthracite, Coal, Lignite.

The families are again divided, as they are either Aggregates, Conglomerates, or Detrital, and the former as they present either a Phanerogenous or Adelogenous structure.—J.M.

II.—RECENT AND FOSSIL ENTOMOSTRACA.

1. A MONOGRAPH OF THE RECENT BRITISH OSTRACODA. By G. S. BRADY. 4to. with 18 Plates. 1868. (From the Transactions of the Zoological Society.)
2. BIVALVED ENTOMOSTRACA, RECENT AND FOSSIL. By Prof. T. RUPERT JONES. 8vo. 1868. (From the Quarterly Journal Microscop. Science.)
3. NOTES ON THE PALÆOZOIC BIVALVED ENTOMOSTRACA: No. VIII. SOME LOWER-SILURIAN SPECIES FROM THE CHAIR OF KILDARE, IRELAND. By T. RUPERT JONES AND Dr. H. B. HOLL. (From the Annals and Mag. Nat. Hist.)

OF the many kinds of minute creatures that leave their shells or skeletons in muds, sands, shell-beds, and coral-reefs, to become integral constituents of clays, limestones, and other strata, few, except Foraminifera, contribute so large a proportion of calcareous matter as the little bivalve carapaces of the *Ostracodous* and *Phyllopodous* groups of the *Entomostraca*. This has long been known, and numerous notices and monographs, often furnished with many good figures, have been published within the last twenty years, illustrating the many different forms of *Bairdia*, *Cypris*, *Cythere*, *Cytherella*, *Cypridina*, *Beyrichia*, *Leperditia*, *Estheria*, and other genera belonging to these low types of Crustacea. The difficulty of correctly assigning the fossil carapace-valves to definite specific and even generic groups, has been dwelt upon in the monographs on the Cretaceous and Tertiary *Entomostraca*, and of the fossil *Estheriæ*, by Prof. Jones, which were published by the Palæontographical Society, and nothing but careful and extensive examination of living specimens, and exact comparison of the limbs and internal organs, as well as of the carapace-valves, could furnish good grounds for either the collocation of apparently similar forms of fossil valves, or the specific separation of some that presented differences of outline, ornament, and other features. Mr. G. S. Brady's assiduous study of the Bivalved Entomostraca, supplementing, and indeed greatly augmenting, the information given to naturalists on this subject by Baird, Norman, Sars, Liljeborg, and others, has eventually put us in possession of a considerable store of facts, illustrating the relationship of a multitude of these little organisms, and enabling us to speak more definitely than heretofore of the probable generic and specific groups to which our fossil Entomostraca are referable. It is not alone in the monograph mentioned at the head of this article that Mr. Brady's researches are to be studied, for in the Transactions of the Zoological Society, in the Annals of Natural History; in the Transactions of the Nat. His. Soc. of Northumberland and Durham, in "Les Fonds de la Mer" (an excellent periodical published by some naturalists at Bordeaux), and in some of the popular scientific journals of the day, many well-considered memoirs written by him are to be found, illustrating very many recent and a few fossil Entomostraca.

The monograph before us puts the British genera and species of Ostracoda into order, with full delineations of their valves, limbs, appendages, and other characteristic features. A table (at p. 478 and 479) gives the distribution of the British Marine species, showing which affect shallow water, and which live in the deep; also which are found on the Norway Coasts, and which occur in the Post-tertiary deposits of England, Ireland, Scotland, and Norway. Of the 111 species of marine Ostracoda found living in the British Islands, fifty occur in the Post-tertiary deposits, and five have been found in the Tertiary strata of England and Europe.

The following British living species have been found in deposits of Tertiary age :—

Cythere punctata, Münster (=*convexa*, Baird). Suffolk Crag; Upper and Middle Tertiaries of Germany.
——— *Jonesii*, Baird (=*ceratoptera*, Bosquet). Suffolk Crag; Upper and Middle Eocene of Belgium and France.
——— *papillosa*, Bosquet. Miocene and Eocene of Belgium and France.
Ilyobates Bartonensis, Jones. Middle Eocene, Barton, Hants.
Loxoconcha tamarindus, Jones. Crag of Suffolk.

The following recent British *Ostracoda*, of fresh-water habits, are found fossil in the Post-Tertiary deposits of England :—

Candona compressa, Koch (=*Cypris setigera*, Jones).
Cypris gibba, Randohr.
——— *reptans*, Baird.
——— *lævis*, Müller (given as *C. ovum* in Jones's Monog. Tert. Entom.).
Candona candida, Müller.

Doubtless this list will be increased by further research.

The collector of fossil *Ostracoda* will still find it very difficult to allocate his specimens to their right groups—especially as some of the valves that have hitherto passed as belonging to *Cythere* may really belong to *Bythocythere*, *Cytherura*, or *Cytheropteron*; and those valves formerly grouped under *Cytherideis* may be *Eucythere*, *Ilyobates*, *Xestoleberis*, *Pseudocythere*, *Schlerochilus*, *Paradoxstoma*, *Paracypris*, or *Pontocypris!* So little could slight differences of valve-structure be regarded of generic value, until they were known to be backed up with differentiation of limbs and other organs. With a better acquaintance of recent forms, the observer has now a better chance of assorting his fossil specimens, if well preserved, but he must not be hasty, nor even too confident.

In illustration of the difficulty the Ostracodist has in his researches, the reader may try to follow Messrs. Jones and Holl in their determination of the several bivalved carapaces they have found in the Lower Silurian Limestone of Kildare. Little but the shapes remain to guide them; and those present but such slight modifications, compared with each other and with existing forms, that evidently the authors approach dangerous ground in attempting to define them, and are at a loss to find distinctive names for their species. Still, it is evident that these old forms must be recognized and catalogued; and whether or no some of them astonish us by their apparent similarity to (and almost identity with) living species, we are glad to see geologists and naturalists attempting to define them, with creditable industry and acumen in working out their relationships, and bringing artistic skill to bear in their delineation.

III.—THESAURUS SILURICUS—THE FAUNA AND FLORA OF THE SILURIAN PERIOD. By JOHN BIGSBY, M.D., F.G.S. 4to. pp. 268. London, 1868. Van Voorst.

IT is impossible to overestimate the value of exact books on any subject, but especially does this apply to those which relate to any branch of natural science. Such a work has just appeared from the pen of another veteran in the ranks of geologists; we say another, because it is not many months since Sir Roderick Murchison completed and issued the fourth edition of his "Siluria,"[1] an extended and more useful form of his original "Silurian System;" and another distinguished and equally laborious author, who has grown grey in the service of geology and its sister science palæontology,[2] has lately completed, in addition to other valuable works, his seventh quarto volume of researches into the history of organic life in the Lower Palæozoic rocks of Bohemia.[3] We need only mention the name of Joachim Barrande to remind our readers of his splendid work upon the Trilobites of the Silurian rocks of the Bohemian basin,[4] and his even larger work upon the *Cephalopoda* of the same area. Such works are lasting monuments of the learning, labour, zeal, and research of their authors. If age and life-long devotion to such labour be individually paralleled, and measured by work done (or published) the new world may be proud of James Hall and his voluminous palæontological researches into the oldest forms of life, as exhibited upon the American continent.[5] These men, and many others with the author of the work before us, seem to have laboured in the same field of science and research, but in very different regions of the globe. Murchison over the oldest rocks of the western parts of England and Wales, Scotland and Ireland, the Steppes and plains of Russia and the Ural mountains, etc., tracing, defining, and correlating the life-groups and Rock-masses of these remote regions with those he had determined and established in the British Islands. The other seems to have lived to labour with determined purpose to work out in the most elaborate detail the physical structure and past life-history of the Silurian rocks of Bohemia, as wonderful in their geological structure as in the richness of the fauna they contain. How well Barrande has performed this task, and how exhaustive have been his researches, the future history of geological science will prove.

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[1] Siluria. Hist. of the older Rocks in the British Isles. 1867. 4th Edition.

[2] Barrande.

[3] Systême Silurian du centre de la Bohême, Vols. for 1865-6-7-8 *Cephalopoda* and *Pteropoda*. Par Joachim Barrande.

[4] Systême Silurian du centre de la Bohême, Vols. 1, 2, Crustacés *Trilobites*. Par Joachim Barrande,

Geological Survey of New York, Palæontology. 6 Vols. quarto.

James Hall, whose palæontological researches in the State of New York are almost without a parallel, still labours as the "State Geologist." Six quarto volumes attest untiring zeal for his favourite science; these are chiefly devoted to the elucidation, description, and history of the organic remains of the Palæozoic deposits of that State.

The author of the "Thesaurus Siluricus" has kept pace with these great geological and palæontological labourers, and, in the volume under notice, has chronicled with faithfulness, not only their results, but those of every reliable authority that the literature of geology supplies; and his own knowlege and research is a guarantee for the value of the compilation and analysis he has undertaken. Few men would have attempted such a task, even had they possessed the requisite amount of practical knowledge and experience necessary; and those who really know the detailed labour, time, and anxiety involved in making some 50 or 60,000 references will best appreciate the service rendered to the student in this department of science in the reduction of mechanical labour alone; and herein lies the great value of the Thesaurus.

We question if any special catalogue of modern times was more wanted or better conceived; but as it is the production of one who has been a laborious student and fellow-labourer in Silurian geology and palæontology for nearly fifty years, it needs no apology. Who has not felt the importance in geological studies of being enabled readily to arrive at facts and reliable data; and without such details as are attempted in the Thesaurus no generalizations or solutions of the great problems of the distribution of life through time and space can be arrived at, for as the author happily quotes on the title page, "The boldest and happiest generalizations must depend on details."

It has evidently been the want felt by the author of the Thesaurus of obtaining a ready knowledge of the distribution of species geographically and biographically, that induced him to commence his List of Silurian life, and embracing the two great kingdoms of Plants and Animals. No such record, or muster-roll of either kingdom being obtainable, except by wading through the details of European and American geological and palæontological literature, and consulting the various works of Barrande, Bronn, Brongniart, Dalmann, Goldfuss, Pander, Von Buch, Wahlenburg, Rœmer, Hisinger, Eichwald, Hall, Davidson, etc., etc.

It is to Silurian time and deposits only that this work applies, and the nearly 9000 species authentically enumerated, geologically and stratigraphically placed, may be received as the exhaustive labours of the author up to the present year, derived from the various works of every reliable author upon Silurian and general Palæozoic Geology. The plan is comprehensive and clear, giving us at once the stribution of every species known to have existed in the Silurian as *of any area* on the globe. The genera are alphabetically arnged under their Sub-kingdom, Province, Class, and Order. The mily is omitted, which we regret, this being an important feature zoological classification. The author of each genus, and date of iblication of name, with important synonyma, is given in every ise where necessary. An alphabetical order is followed in the regisation of the species, which are in every instance stratigraphically aced in one or other, or all of the sub-divisions in which they occur the British, American, Bohemian, Swedish, Norwegian, or Russian stems—initial letters in this first column, headed Sub-division, signating the particular horizon in any given stage (in the above stems) in which the particular species is found. The column headed enera, Species, and Author is followed by three others, termed ages, Lower, Middle, and Upper, expressive of the sub-division of e Silurian system into these three natural life-groups. In each of ese columns also occurs the geographical position of the particular ecies, thus enabling the student to fix the locality and distribution the forms, and so mentally to re-people with life these old mane areas; for geographical distribution is at least equal to if not greater importance than stratigraphical position; the former termines its place in space, the latter in time—the one its lateral tension over a given sea-bottom, the other its vertical duration or ngth of specific life. At the close of the analysis of the genera id species of each order is appended a generalized geographical immary, showing the distribution of the genera over the globe. he advantage of these tables cannot be estimated until used. The der *Trilobita* alone (pp. 72–74) amongst many others commends self to our notice. The table contains every known genus (no fewer an 126) named in alphabetical order, and also gives their appearance the several localities, no less than 42 parts of the globe being tabuted to receive this group, viz. 24 in America, and 18 in Europe id Australia. The genus *Calymene* occurs in 32 out of the 42 areas imed; *Cheirurus* in 26; *Illænus* in 30; *Phacops* in 26; *Asaphus* in 23; *canthopygæ* in 1; *Cyphoniscus* in 1: the remaining 120 in every prortion. All the orders of the animal kingdom known in the Siluan rocks are treated in the same way.

It is the tabulation of such individual facts that leads to high eneralizations, and a positive knowledge of the distribution and ature of life over the globe, and renders it in our power to re-people id restore lost continents, marine areas; to map out geographical itlines, and to show the probable depth and shape of palæozoic as: to understand those groups and communities of life, those cal colonies, and the missing links in time which perplex the alæontologist at every stage of his investigation, especially in the ilurian regions of Wales, Bohemia, Scandinavia, Spain, Canada, id America. Fifty pages of facts and observations herald the able itself, these not only explain the use of the Thesaurus, but ey forecast and lay down in short and terse paragraphs some of the rand *deductions that* may be arrived at, through the mass of material contained in the 200 pages of seemingly unattractive matter, every line of which however helps to build up a catalogue of past existences and their history. The Thesaurus exhibits the complete analysis of Silurian life in all its phases, and the highest generalizations and philosophical deductions may be drawn from the great table itself. The fifty pages alone testify to the value of details, and how much we are indebted to the patient labour of the author, who hopes that the "more obvious facts and inferences to be derived from the body of the work will invite a broader, more leisurely, and more able study than is in his power to bestow."

Amongst the more prominent questions arising from a close analysis of the Thesaurus, the author has selected twelve; three of which are examples of the mode of analysis that the *orders* may be subjected to, and the facts which may be deduced from them.

The number of orders or groups adopted in the work are seventeen, but three only are selected in the introduction to show analysis, viz., the *Gasteropoda*, *Trilobita*, and *Echinodermata*, these being evidently chosen as showing greater diversity and detailed interest. Nine other questions or enquiries are selected—two of them having reference to the Primordial stage and the Bohemian area, whilst seven embrace questions of the highest importance to a right and philosophical understanding of the distribution and laws of life through all time.

1. *Universality;*—is here used in a physical as well as natural history sense. The former refers to the once universal distribution of the Silurian seas, (and, as a consequence, of Silurian rocks,) more or less over the globe; and, secondly, the universality of the distribution of numerous genera and species in and through one or other of the three stages comprising the Silurian system.

Examples occur through the Thesaurus of many species of Mollusca occurring in twenty-five different countries, extensive and far apart, a proof of the amount of time required for their distribution and migration in space; other genera, on the other hand, lived on during the deposition of a whole group of rocks, thus illustrating their duration in time. In this way we know of the range of *Theca triangularis* through all the many different sediments comprising the Hudson River group in North America, and that it is also a common British Pteropod in the Caradoc rocks of Ireland, Denbighshire, Westmoreland, Spain, etc. The Thesaurus shows us that 210 species of all orders are common to Europe and America; sixty European Silurian genera are common also to South Australia; and eighteen species of the Graptolites of Australia are also common to, and identical with, those of North America and Europe.

Some Silurian fossils may be said to be cosmopolitan. The Thesaurus exhibits this on almost every page. After tersely noticing many facts connected with, and as proof of this universality of the Silurian epoch, Dr. Bigsby sums up this commencement of the universality of epochs by stating that "*it is a great fact and enables*

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[1] These are—1. Universality. 2. Locality. 3. First appearance. 4. Duration, longevity, and extinction. 5. Migration. 6. Recurrence. 7. Divergence.

us to apply to one end of the earth information and reasoning gathered at another."

2. *Locality.*—Life is dependant upon local conditions and local influences, which regulate its nature, condition, and almost absolute quantity,—the resting place, the feeding ground, the home, are all fixed by the concentration of conditions suitable to the well-being and conservation of life, either from the plain to the mountain top, or from tide mark to the most profound depths of the ocean. The Thesaurus exhibits and enables us to reason upon the distribution, and zone selected by species in hundreds of instances. In Silurian times, as now, every large area of sea bottom had its own conditions, its own fauna and flora; and we see, through the elaborate table before us, that old disconnected areas are nevertheless, through generic, if not specific identity, connected by the common ties of the great and predominant types of life; that time and attendant circumstances allowed for distribution. The Thesaurus also declares to us, through the analysis of its closely printed tabular columns, that the physical state of land and sea was in Silurian times, as now, restricted as to population, to those localities where the conditions were most favourable for the maintenance and development of life; and, above all, we are enabled to arrive at conclusive evidence that the maximum of life was, as now, usually local, *i.e.* adopting abundance, variety, and rank as the test. In fact, localization in time and space, a matter so essential to understanding the past distribution of organic remains, can alone be wrought out by means of the facts and details spread through the work before us. The author, at page xxxiv., in speaking of the localization of life in time or space, as deduced from his Thesaurus, says, "The rich Primordial beds of Western Newfoundland and of Quebec—the crowded *Pleta* beds of Esthonia and Russia—the Trenton Limestone of the State of New York—the Bohemian beds E. e 1, 2 (=Upper Silurian: Third fauna, Lower Limestone)—some of the Welsh beds near the same horizon as those of Prague—the Lower Elderberg rocks of New York, are all striking examples of localization in time and place." Again, "Parts of the Middle Silurian of Wales and New York present a great dearth of life, for well known reasons; even the rich Silurian strata of Bohemia are occasionally only so in the form of an oasis, the sediments around them having scarcely a single tenant."

The Potsdam sandstone (Primordial) of the St. Lawrence and Mississippi valleys gives no signs of life for many thousands of square miles except in patches, peopled chiefly with *Lingulæ* in incalculable myriads. In these, amongst a host of other deposits, and localities, the Thesaurus conspicuously shows and proves the doctrine of the influence of locality on the nature and amount of life. So important is the question of locality (*i.e.* definite localities) in connection with the distribution of life, that we are obliged to look at some special groups as having existed during Silurian times in this or that particular area only. Such is the case with the group of fishes, certain genera of the *Trilobita*, and peculiar families of the *Gasteropoda* and *Cephalopoda*. The Thesaurus, for example, catalogues sixty species of *Asaphus*, only *four* species of which genus occur in Bohemia and ten in Britain; the local distribution of such genera as *Maclurea*, the peculiarities of the geographical distribution of the *Brachiopoda*, etc., can only be arrived at through recasting again the facts of locality and appearance given in the "table." This old geographical distribution of certain forms of life can be approximately explained by the peculiarities of the present fauna of Guadaloupe, the Madeiras, St. Helena, Madagascar, Australia, South America,[1] etc. etc. Clearly, then, the 9000 Silurian species, here for the first time catalogued, will well repay the student wishing to construct for himself tables of life and localities, or to comprehend the faunas of the old geographical areas once occupied by the Silurian seas.

3. *First appearance.* It is with the earliest-known expression, or dawn of life on the globe, that the compiler of the Thesaurus deals; but we may ask, who has seen, or knows, where the line has *yet* to be drawn, *by any system*, that shall say, "below this there are *no remains* of a former life. A few years since it was commonly believed that the term "Primordial Zone" (as used by Barrande, Murchison, and others) defined the limit of our knowledge of the downward range of organic life. This view has long since been abandoned, for thousands of feet below the so-called Lower Lingula flags of Great Britain and Bohemia we have life entombed in the metamorphosed Laurentian rocks of Canada, and in the older Cambrian of Wales we are daily disentombing some new forms of life from sedimentary rocks of the highest antiquity, but "first appearance as yet," does not settle the date of the commencement of life; this we have still to learn. Thus much we do know, that certain groups of organized beings make their appearance much about the same time, viz., the *Articulata*, *Brachiopoda*, and *Annelida*, which are all associated in the Primordial beds, and also in the underlying and older Cambrian.

4. *The life or duration of Species.*—This and the determination of a species is one of the vexed questions of the day in Biological science. The statistics of life, as chronicled in the Thesaurus open up this question, and enable us to trace the vertical range of life and development of species through vast lapses of time, and whatever may be the causes that modify forms (*with which the Thesaurus does not attempt to deal*), we are nevertheless enabled to see and trace the range of those forms called species, and which, as recognized, aid the Geological student in the determination and fixing of certain definite lines of demarcation, and in the construction of systems. Genera are less affected than species, and have lived on through a lapse of time beyond our conception; whereas the life of an individual is ephemeral, for, says the author of Thesaurus, so "numerous are their generations that it is idle to speak of them as less than hundreds of thousands" (p. xxxviii). Under this head the author, in his introduction, enumerates and suggests some important facts for our consideration, and clearly sets forth the views of Barrande upon the *relative* measurement of organic existence and longevity.

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[1] In fact, they represent "outliers," or remnants of old Pre-Silurian faunas, not entirely swept away by the stronger influx of Silurian life.

taking the Bohemian *Cephalopoda*, *Brachiopoda*, *Trilobita*, *Gasteropoda*, etc., as groups whereon to establish his views of duration, succession, and measurement of stages, periods, or eras.

Extinction of Species, etc.—If any branch of geological enquiry interests the palæontologist more than another it is *the beginning and ending* of forms called species, which includes also their range. We are enabled to arrive at a solution to this important question through the Thesaurus. The great subdivisions of the geological series are based upon the first appearance and persistence in time of a certain community of species, like that marking the Silurian, Devonian, Carboniferous, Oolitic, Cretaceous, and Tertiary periods exhibit; the close of each epoch being marked by the extinction, modification, or migration, of the life of the period to a greater extent than at other horizons. And thus we find Silurian life was greatly modified, though of course not discontinued, everywhere on the same horizon. In Britain *two* species only can be said to be common to the Silurian and Devonian periods.

One of the causes of extinction is, and ever has been, in universal operation, more or less everywhere; this is oscillation of level, which constantly alters the form and proportions of land and sea; the temperature and all the physical conditions attendant upon them, and consequently also the life thereon and therein, the peopling of the many stages of the Silurian system can, both in their advent and extinction, be arrived at through the details set forth in the first column, entitled "Subdivision," and the three following headed stages in the Thesaurus. To our minds the philosophy of the whole question of locality, duration in time, extinction, migration, recurrence, and divergence in species is based upon and governed by the same laws which regulate the relative amount of sea and land, both vertical and horizontal, and with it the life subjected to those vicissitudes. Habit is changed, locality shifted, and all must either accommodate themselves to new feeding-grounds and homes, or perish. Extinction or migration, accommodation or change, must follow, whether the time involved in effecting the change be long or short. The author of the Thesaurus happily and briefly explains in the introduction many of the phenomena attendant upon such ever-recurring conditions of the sea and land. The table states this, but registers only the fact of occurrence; and when we know that the whole of the 9000 species analysed therein *seem* to have passed away at the close of the Silurian epoch, we may well endeavour to account for, or propound a doctrine which shall satisfactorily explain away this apparent extinction, without having recourse to the old notion of cataclysms.

5. *Migration.*—Transport and migration are two distinct acts, one passive and dependant, the other an individual power, governed by will or instinct. Marine and fresh-water forms, when life has ceased to perform its functions, are transported by currents, waves, or streams. The remains of older formations, through the influence of denudation, are occasionally [illegible]ed in conglomerate-beds, or transported to other sedimen[illegible]tion or removal from place

to place under physical changes and vital laws, has ever been a great fact. The fauna of every great geological epoch (and the flora in many cases also), has, through all its changes, whether slowly or suddenly, been subject to the vicissitudes of life through the long voyage of time. The colonization of unoccupied spots *from* crowded areas, changes of place through reproduction and individual wants, the great influence of "natural selection, and the struggle for existence," are inducements to, and causes of migration. The grouping then, or communities of organic remains, the colonies of olden times that lie entombed in the shales, limestones, and sandstones of the Silurian rocks, are to us but expressions and faithful witnesses of the distribution of life through that long epoch; sea-deserts of sand, and barren wastes, unsuited to and impassable by many of the mollusca, and other creatures, occurred then as now to arrest migration, or concentrate a peculiar fauna in one spot. Such patches of fossil life in the midst of old untenanted wastes in the Silurian rocks are well-known to all investigators. Some beds of *Trilobita* which (like an oasis to the collector) really do occur amid such wastes in the Bohemian basin, and research tells us that whole communities have returned to the country from which they had migrated, or had long abandoned. One amongst others of this kind of repossession of an abandoned area is illustrated by Mr. Godwin-Austen, as occurring in the Palæozoic rocks of the Boulonnais, where alterations or alternations of level have introduced into the same area, successively, distinct assemblages of suitable marine life, one or two of these accomplishing a repetition of occupancy (Quart. Journ. Geol. Soc. Lond. ix. p. 244).

The migratory power of the mollusca is undeniable, but it varies in certain groups. The Pelagic *Cephalopoda*, *Pteropoda*, etc., being free dwellers in the open seas, drop on, and into, all grounds on the ocean floor, and live independently of all sediment, whilst currents sweep away the Byssoid *Brachiopoda* and fixed *Cœlenterata* (corals).

Bathymetric conditions also govern the distribution of life—and time being granted—with shore-lines, and coasts, and some constancy of ocean depth; and the distribution of the ocean fauna at the present day, may be applied to the faunæ of every past epoch. Centres of distribution or migration may be determined by the use of the Thesaurus for any place so well worked and understood as Great Britain, Bohemia, Esthonia, etc., and much of America. The author at p. xliii. of his introduction gives a table (table U) showing the direction pursued by 210 species which are common to North-East America and Europe (Western chiefly), or the direction of species in transitu between North America and Europe, together with the "Isozonals" of both hemispheres. He enumerates 15 groups, and shows by means of the Tabular Thesaurus that 35 species migrated West from Europe to America, and 30 East from America to Europe; and also shows that 145 species, or double the number of migrants, are "isozonal," *i.e.* are common to the two hemispheres in the same rock, or to the Silurian system; and six out of the fifteen groups exhibit no trace of travel or migration, although they are large and important, namely, the Echinodermata 294 species; the *Lamelli-*

branchiata-Monomyaria, 1 only out of 1635; *Dimyaria* none out of 526; *Gasteropoda* 1 only out of 944.

We select the following table out of many in the introduction to show the mode of generalization. All the twenty-six tables are constructed from the body of the Thesaurus; — Dr. Bigsby remarks, a Montreal fossil we trace Southwards to Pennsylvania, Westwards into Minnesota, and Eastwards to Anticosti; and Minnesotans are found in the Texas, etc., and the Australian *Diplograpsus pristis* (Hisinger) also flourished in Britain, and Canada on the same zone. The same species of Trilobites, Corals, and Brachiopods are found along lines of coast 6000 miles long, traceable from Canada to Russia, Britain, etc.

DIRECTIONS.	Plantæ.	Amorphozoa.	Cœlenterata.	Echinodermata.	Annelida.	Trilobita.	Entomostraca.	Polyzoa.	Brachiopoda.	Monomyaria.	Dimyaria.	Heteropoda.	Gasteropoda.	Cephalopoda.	Pisces.	Uncertain class.	TOTAL.
From Europe to America (W)......	2	2	7	...	2	8	...	1	6	...	...	4	...	3	...	...	35
From America to Europe (E)......	...	1	4	...	...	1	3	...	14	1	...	2	1	3	...	...	30
The Isozonals in both hemispheres	1	2	6	...	...	15	1	30	52	4	8	10	7	9	...	...	145
Total.........	3	5	17	...	2	24	4	31	72	5	8	16	8	15	...	...	210

6. *Recurrence of vertical range.*—The author of the Thesaurus devotes much space to the discussion and elucidation of principles in this highly important question in stratigraphical Geology. The value of the whole Thesaurus, its well-stored columns and facts, is apparent when we come to the question of the recurrence of species in time; their upward passage and life through long ages and successive generations. The task of searching whole libraries for such details (which otherwise must have been done by the student) are avoided if we consult the Thesaurus with fidelity; and whether we hold the views of those who believe in the limited duration of species in time or not, the facts as they occur all through the Thesaurus will stand the same. We are enabled to trace the range of any given species through the different stages, and may, we think, modify the notion possessed by some Palæontologist as to the distinctness of species found in different horizons; for progress daily teaches us that we must not too strictly narrow the stratigraphical limits of species, neither would we, on the other hand, advocate destroying all sharp lines of demarcation; both views have their value, when our diagnoses are not too forced or narrow. Denudation and breaks in time must have their weight even here. "Species," says the author of the Thesaurus, "are the principal time-tests, genera and families run through so many stages and epochs that they characterise none." The opposite is the case, however, with species well determined,—they are *the only* tests of age and succession, and in great overlaps and some apparently superposed strata, species only will determine the conditions. The author of the Thesaurus has constructed out of his work a very important synoptical view of Silurian

life in reference to vertical range or recurrency, as known in 1865. In table x., p. xlv., the entire animal kingdom then known fossil (5,184 species) in the Silurian strata is analyzed; the number of species in each stage or division of the Silurian system or species typical of one horizon (Silurian) is given, the recurrent number is then shown for all the groups, and the average given for each group. To show the importance of the Thesaurus in the analysis of such facts, we may mention amongst others that throughout the sub-kingdom *Cœlenterata*, numbering 311 species, no less than 70 (or 18 per cent.) occur in a recurrent state, in the proportion of 51 for the Lower Silurian, 14 for the Middle, and 5 for the Upper; the *Trilobita*, possessing 845 species, in the proportion of 91, 16, 32=139, or 14 per cent. of the whole order; and so on through the animal kingdom, every individual species can be traced in the body of the work: and believing in the fidelity and trustworthiness of the author, and the pains he has taken to arrive at truth and exactness, we may assume that the facts and their deductions are reliable. The universality of recurrence in marine life, whether ancient or modern, is traceable, and common to all and every part of time,—every succeeding epoch, from the earliest upwards, exhibiting this. It may be, as the author states, a measure of vitality or capacity for enduring change of food, pressure, temperature, etc., the number of recurrents being a measure of new conditions, and the conditions favouring or rendering this possible are simplicity of structure, fecundity in reproduction, longevity, power of locomotion, facility in transportation, etc. etc. Whilst sediments (many of which recurrents tolerate) are slowly accumulating, generations mount up with the increasing thickness. Entire areas of the world show these conditions exemplified through the *Trilobita*, *Gasteropoda*, *Cephalopoda*, and *Cœlenterata* of the Silurian stages. So largely is this question dealt with in generalities and suggestions in the Thesaurus that we must refer the reader to the section, and tables X and Y, pp. xlv. and xlvii.

7. *Divergence.*—The author of Thesaurus has constructed a table at page 49, which he terms "Molluscan sea-grounds," ranging over eleven large regions. It is done with the view of arriving at some definite conclusions as to the nature of the sea-bottom, its sediments, and feeding-grounds for the mollusca, etc., etc.

This table may be applied to the same or similar conditions through all Silurian time; eleven kinds of sea-bottom are also registered, which may be assumed as habitats, and over which the dredge has passed. Forbes investigated the sea-grounds, etc. of North-west Scotland, South and West England, and the Ægean Sea; J. Gwyn Jeffreys, the British seas generally; McAndrews, the North-east Atlantic, Vigo, and Carthagena Bays, the Mediterranean, and Norway; Cumming, the East and West Pacific; C. B. Adams, Panama and South America; and Hinds, the West Pacific.

In 1863 3138 species had been dredged, and in these there appear to be 1993 divergent species. The last four columns in the table may now be considerably added to, but the principle is the same. The result of 5000 acts of dredging are recorded by these experienced naturalists in eleven large areas and sea-bottoms. The study of these mens' labours must be the interpretation and revelation of nearly closed basins, long shores, and open sea dredgings, with their treasures and results.—R.E.

(*To be continued.*)

CORRESPONDENCE.

I.—NEW METEORITE FROM SOUTH AFRICA, Etc., Etc.

Sir,—During a recent visit to South Africa I was staying a few days at Colesberg, some 600 miles up the country, when I accidently heard from a trader, who had just returned from some distance beyond the Great Orange River, that Captain Nicolas Waterboer, the Griqua chief, had a meteoric stone. Now, it is frequently the case when you hear of an aerolite in this manner, that some considerable doubt arises as to whether it really is a true meteorite or an imagined one; however, as I was now on my way up the country in that direction, I took note of the report and resolved to satisfy myself as to its being a genuine one.

After three weeks or more, on my arrival in Griqua town, I found out that the report of this stone was quite correct, and I obtained the following particulars from the Rev. James Good, the Missionary at Griqua Town. It was brought to him on or about the 1st of April this year by a Griqua who saw it fall near his hut on March 20, 1868, who said it smelt strong of sulphur, and was warm when he picked it up. It fell at Daniels Kuil, in Griqua territory, about two days journey N.N.E. of Griqua Town, and was brought into the town by the native who saw it fall and who offered it to Mr. Good, who, not being much interested in it, told the man to take it home again with him; the man, however, gave it to Captain Waterboer from whom I obtained it.

This meteorite is of small size, weighing only 2 lbs. 5 oz. and was the only one seen to fall. It contains a very large amount of free iron disseminated evenly through it, together with Troilite, Schreibersite, etc. This stone contains more iron than any other I have seen, but in a very fine state of division. It is of a dark greyish colour with a fine granular texture, speckled with small brown patches, owing to the alteration of the iron present; most of the iron seen on the broken surface of the interior of the stone is in extremely minute points, which glitter like the broken surface of a piece of sandstone. Frequently in meteoric stones there appears to be small roundish grains, sometimes so abundant as to give the stone an Oolitic character; this is not apparent in this specimen.

The crust on the outer surface is of a dull blackish colour, and immediately below, for a thickness of perhaps one-eighth of an inch, the stone is browner in colour than the rest of the interior, owing to partial alteration. When this aerolite came into my hands it was broken into two parts, and the fractured surfaces were very much altered, the iron being much oxidised, thus rendering the stone much browner than at a fresh fracture.

Professor A. H. Church has very kindly analysed it with the following results:

Density	3·657
Nickel-Iron	29·72
Contains: Fe. 94.72 Ni. 5.18	
Troilite	6·02
Schreibersite	1·59
Silica and Silicates	61·53
Oxygen, other substances, and loss	1·14
	100·00

The meteorite gives off sulphuretted hydrogen when treated with acid.

I have just succeeded in obtaining a cast of the stone in plaster of Paris, which, being coloured, is a perfect facsimile of the whole meteorite as it fell.

It is remarkable, considering the large extent of country now being much travelled over, even for a very great distance, that so few meteoric stones or irons are found in that part of the globe. India has of late years produced a large number, some 40 or 50, while in the Southern portion of Africa some 7 or 8 are all that we know of.

II.—Meteoric Iron from South Africa.—On my return to Cape Town in August last from the Orange River, on visiting the South African Museum, Mr. E. L. Layard pointed out to me a small piece of meteoric iron, the weight of which was only about six or seven pounds. It was, as usual with these irons, much altered and decomposed on the exterior surface, evidently owing to the large proportion of the meteoric mineral-iron sulphides, which, as is well known, attract much moisture from the atmosphere, thereby causing the mass to crumble and fall to pieces. Mr. Layard was kind enough to give me a small portion of this iron, in which part of the metal was not altered in any way. This meteoric iron was said to have been seen to fall at Victoria, West, some distance up the country, in 1862. It has not been analysed, and its existence seems to be unknown in Europe.

I have had my specimen polished and etched in the usual manner; it exhibits the crystalline markings similar to those seen in the other meteoric irons, but perhaps in finer and more delicate lines.

III.—Ancient Stone Implements.—I procured several stone implements in August last, during a recent visit to South Africa, that were found on the Cape Flats, a large flat extent of country near Cape Town. The materials from which they are fashioned are not flint, though some have a very flinty appearance; they are mostly made of a kind of quartzite, or very hard and compact sandstone of a yellowish brown colour; some are made of a variety of jasper, though somewhat of a coarse texture; these stones being found plentifully in various localities in the southern part of the Cape Colony; some of these sandstones have been assigned to the Devonian age, and many of them are extremely friable; occasionally we find these implements made of a cherty stone, but none of true flint; they are mostly arrow-heads with some knife flakes. I have also a large round flattish hammer-head (with a round hole in the centre), from the same locality, the weight of which is about two pounds.

JAMES R. GREGORY.

ON *HETEROPHYLLIA MIRABILIS*, DUNCAN.

SIR,—In the GEOLOGICAL MAGAZINE of this month (October, 1868), Mr. John Young, speaking of *Heterophyllia mirabilis*, and *H. Lyelli* (as described by Dr. Duncan in the Transactions of the Royal Society), suggests that the error, as he considers it, of representing the hook-shaped processes attached to *H. mirabilis* as articulated, may have arisen from the specimens examined being worn or indefinite. This was not the case. The corals, which I believe were the property of Mr. Thomson of Glasgow, were perfectly sharp and distinct. The bulb or tubercle, with a pit in its centre, and the slight concavity at the base of the hooklet being too decided to admit of any doubt or misconstruction. Besides, in nearly every case the hooklets had separated at the bulb. Supposing the articulation to be a mistake, these fragile appendages would hardly break invariably at that point where they are stoutest and strongest. Yet in all specimens that I have seen—and I have seen many—such is the rule. At the time the plates for Dr. Duncan's paper were drawn I had been intimately acquainted with corals, examining them day by day for a space of six years, and the conviction is strong upon me that I must have possessed sufficient discrimination to distinguish between a fracture and an articulation. That a Zoophyte has no right to this articulation is a point about which I know nothing. Like other creatures, it is possible they may occasionally exhibit eccentricities.

G. R. DE WILDE.

ON *HETEROPHYLLIA MIRABILIS*, DUNCAN.

I have, at the request of my friend Mr. Henry Woodward, very carefully examined, under the microscope, several specimens of this curious coral (described by Dr. Duncan in the Philosophical Transactions for 1867) forwarded to Mr. Woodward by Mr. John Young, Under-Keeper of the Hunterian Museum, Glasgow.

Not having seen the specimens figured by Mr. De Wilde in Dr. Duncan's plate, I cannot venture on any positive assertion as to whether or not those particular specimens have been rendered with that artist's customary accuracy;—but I have no hesitation in stating that it is easy to select specimens from those sent by Mr. Young, which present rows of tubercles, the exact counterpart of those figured by Mr. De Wilde.

On the other hand, however, there are amongst Mr. Young's specimens, some which present characters differing greatly from those figured in Dr. Duncan's plate, and in which the hooklets are broken off at various distances from the costæ—in some cases even close up to the body of the coral, leaving a concave cicatrix instead of a tubercle.

The condition of these could be best explained by an illustration which, if desired, I shall be happy to draw.—Edward Fielding.

London, *22nd October*, 1868.

Note.—We feel sure that Dr. Duncan will be glad to have attention called to his interesting paper on *Heterophyllia*, and also to have the testimony of so able an artist as Mr. Fielding to the accuracy of Mr. De Wilde's delineations. We are quite certain that he will himself be only too happy to re-examine a point upon which, possibly, something more may be determined.

Mr. Young, in his paper (Geol. Mag., October, 1868, p. 451), says, if a coral had spines articulated at their bases, upon rounded tubercles, such a structure would be quite an anomaly in a zoophyte.

We must beg Mr. Young not to reject a discovery because it is anomalous. Palæozoic life-structures present many strange features. Whether we accept or reject the doctrines of evolution and descent with modification, we cannot fail to observe many forms which present what Prof. Owen has aptly termed "a more generalized type of structure," than representatives of the class now existing.[1]

In illustration of this we would refer to an admirable paper which appeared in this Magazine in 1866, Vol. III., p. 356, On *Zoantharia Rugosa*, by Dr. Lindström (with a Plate). The author shows that this remarkable group of corals (before referred in part to Corals, and in part to *Brachiopoda*) were all furnished with an operculum or valve! Surely this is a still more wonderful and anomalous structure in a coral, than the lateral spines on *Heterophyllia mirabilis*.

Nor should it be assumed that an appearance like that of a ball-and-socket joint *necessarily implies* movement; for we have among the *Echinodermata* (both fossil and recent) immoveable and moveable spines, the former of which, when removed, leave an appearance similar to that of the latter. Such structures—like rudimentary appendages—seem rather to indicate what the earlier state of the creature may have been, than what it now is.

Among the *Crustacea*, spines exist, which, like the immoveable spines of some Echinoderms, present an articular surface, not a fracture, when they are removed (*e.g.* the spines on the rostrum of *Palæmon* and on the margin of the thorax of *Limulus*).—Edit. Geol. Mag.

SYNCHRONOUS AGE OF THE GRAYS AND ERITH BRICKEARTHS.

Sir,—In reference to the Brick-earth of Erith and Crayford, which, in my paper on the Post-glacial structure of the South-east of England, published in the 23rd volume of the Journal of the Geological Society, I regarded as being distinct from that at Grays, and of an age anterior to the main sheet of the Thames gravel, I shall feel obliged if I may be permitted, through your pages, to state that I have since satisfied myself that this was an error; and that, similarly to the Brick-earths of Grays and of the Lea valley, it belongs to the lower or fluviatile terrace of the Thames gravel formation (x 5' of my papers).

I have seen no reason to qualify any of the other opinions expressed by me in reference to the beds of the Thames, East Essex, and Canterbury heights gravel series.

Searles V. Wood, Junr.

Brentwood, *October* 10, 1868.

[[1] We strongly recommend the perusal of Professor Huxley's Lecture "On the Animals which are intermediate between Birds and Reptiles" as bearing on this subject. See Geol. Mag. August, 1868, p. 357.—Edit. Geol. Mag.]

DISCOVERY OF *BOS PRIMIGENIUS* IN THE LOWER BOULDER-CLAY OF SCOTLAND.

SIR,—Mr. Robert Craig's letter in the last number of the MAGAZINE does not require an elaborate reply. Mr. Craig seems to think that the Lower Boulder-clay of Scotland is always "a tough dark blue clay;" and as the deposit overlying the stratified materials, in which the skull of the great ox was found, is "mixed with sand and gravel and altogether freer" than the underlying Till, it cannot, according to him, be true Boulder-clay. Mr. Craig will be surprised when he learns that true Boulder-clay does not always maintain the character of a "dark blue," or even of a "tough" clay,—that, on the contrary, it not unfrequently becomes loose and earthy,—that just such a deposit, as that which he imagines I have made a mistake about, may be seen in hundreds of sections throughout the country, sometimes overlying, sometimes overlain by, and in other places graduating into stiffer Till than itself. And he will no doubt be gratified to hear that the same Boulder-clay (sometimes "tough" and sometimes "free") often shows interstratified masses of clay, sand, and gravel, similar in all respects to those which have yielded the remains of the great ox.

Mr. Robert Craig remarks that both in my sketch-section and in the letterpress description I have overlooked "the fact that the Lower Boulder-clay rises up through this stratified bed (*i.e.* the deposit from which the fossil remains were obtained), throwing it out altogether for more than one hundred yards in the section." Now if Mr. Craig will again refer to the section I gave he will observe that I have shown (Fig. 1) the *Bos*-beds thinning out to south-west, and the underlying and overlying Till coming together. If I had been describing in minute detail the geology of the district, I might have transcribed from my note-book the whole of the section exposed; but for the purpose I had in hand that would have been a work of supererogation. It was only necessary to point out that the strata of clay, sand, and gravel, in which the fossil lay embedded, were actually enclosed in what I believe to be deposits of Lower Boulder-clay age. The former, after disappearing for a short distance, again come on underneath the Till; or, as I stated in my communication, "the Till further up the valley towards Shillford continues to exhibit intercalated beds of clay, sand, and gravel." Again, Mr. Craig misunderstands me when he says that I consider the overlying and underlying deposits as identically the same. I merely remarked that "I noticed *no material difference*" between them, —nothing that could lead me to believe theyh ad different origins.

I have said this much because I am unwilling that any doubt should rest upon the matter. The section is gradually being obliterated. The last time I saw it, it was decidedly in a "bad way;" and when the Railway works are completed the resting-place of the great ox will be as difficult to find as that of the Prophet. Knowing that such must be its fate I made a very careful examination, and from time to time revisited the spot to watch the progress of the cutting, but never saw anything to throw doubt on the conclusion I *first arrived at.*

Since my first visit to the section, my colleague, Mr. Croll, has examined the deposits, and agrees with me in assigning them to the Lower Boulder-clay. And I learn through him, that Mr. Bennie, of the Glasgow Geological Society (than whom no one is better acquainted with the superficial deposits of the neighbourhood of Glasgow), had seen the section before the appearance of my short "note" in the MAGAZINE, and had come to the same conclusion as I did; nor, on a second visit, has he seen any reason to change his opinion. JAS. GEIKIE.

LOUDOUN HILL INN, DAWEL, KILMARNOCK, *12th October*, 1868.

THE PLEISTOCENE FRESHWATER DEPOSIT AT HACKNEY DOWNS.

SIR,—Having had my attention directed to a letter by Mr. G. J. Smith in your last number, which imputes inaccuracy to Mr. A. Tylor and something worse to Mr. Skertchly, I think it my duty to explain the matter.

The locality was pointed out and some shells were given to me by Mr. Skertchly. Those shells I took to Mr. Smith, an old friend of mine, and we appointed a time and went together to visit the spot. This was his first visit to the place; *afterwards* he made other visits in company with Mr. Baily. Mr. Smith is right when he says he does not know Mr. Skertchly, but I have no doubt he can make a pretty shrewd guess as to who he is; for, if his memory has not failed him, he must know that I informed him from what source I obtained them. ALFRED GRUGEON.

DALSTON, *October 16th*, 1868.

MISCELLANEOUS.

IMPORTANT DISCOVERY OF REMAINS OF *DIMORPHODON MACRONYX* IN THE LOWER LIAS OF LYME REGIS, DORSETSHIRE.—In the month of March last a remarkable Fossil was forwarded by Henry Marder, Esq., M.R.C.S., to the authorities of the British Museum. It consists of the entire caudal series of vertebræ of a Pterosaurian having a close resemblance to the tail of a *Rhamphorhynchus* from the Lithographic stone of Solenhofen. The entire series of vertebræ, which are long and slender, is 20¼ inches. In August last the Earl of Enniskillen reported to Mr. Waterhouse (the Keeper of the Geological Department) that he had seen, at Mr. James W. Marder's, at Lyme Regis. a very perfect specimen of Pterodactyle. This beautiful fossil (which proved to be an almost entire example of *Dimorphodon macronyx*) has now been secured for the British Museum, and Professor Owen, the Superintendent of the Natural History Departments, is engaged in its description. The point of greatest interest in this new fossil, is the evidence it furnishes that the caudal series, above noticed, really belonged to the *Dimorphodon*, a portion of a tail having the same slender, elongated, hour-glass-shaped centra to the vertebræ, and embedded in similar ossified fibres, having been found associated with this remarkably perfect skeleton of *Dimorphodon.* Professor Owen's paper will be looked forward to with great interest.

THE

GEOLOGICAL MAGAZINE.

No. LIV.—DECEMBER, 1868.

ORIGINAL ARTICLES.

I.—SOME OBSERVATIONS ON THE SUPPOSED INTERNAL FLUIDITY OF THE EARTH.

By G. POULETT SCROPE, Esq., M.P., F.R.S., etc., etc.

ALLOW me to make a few remarks on the two interesting papers contained in your last number,—one by M. Delaunay, on the Supposed Internal Fluidity of the Earth, the other by Mr. Shaler, on the Formation of Mountain Chains. I wish, in the first place, to protest against the assumption contained in the first paper (pp. 507 and 509) that the internal fluidity of the globe is "generally accepted by geologists," on the evidence of its high internal temperature. No doubt the arguments employed in that paper go to shew that, whether fluid or rigid within, the precession and nutation of its axis would remain equally unaffected. So far, therefore, the well-known astronomical argument of Mr. Hopkins and Sir W. Thomson, as to its entire or nearly entire solidity, must be considered to be invalidated. But as Mr. Shaler justly remarks in the second paper, p. 512, "the proved increase of temperature from the surface towards the centre, and the extreme elevation of heat which must exist at considerable depths (as shown in volcanic and other igneous phonomena) cannot be regarded as evidence of general fluidity, until it has been shown that the internal pressure has not a greater influence in preventing liquefaction than internal heat in producing that condition."

Theorizing on the probable conditions of the solidification of the earth, on the supposition of its having cooled from an originally gaseous or fluid state, Mr. Shaler follows and sustains the view suggested by Mr. Hopkins (very properly referred to in a note), namely, that the process probably began at the centre, but that as it advanced towards the surface there must have been a time when the remaining liquid matter, being of inconsiderable thickness, the surface also would begin to solidify by radiation of its heat into space, from which time the further solidification of the interior would proceed in two directions, outward from the central nucleus, and inward from the outer crust. Ultimately the whole might be entirely solidified, or some portions of liquid matter might remain in a thin belt, or rather in pockets or vesicles, here and there, at varying, but still moderate, distances from the outer surface. All this I have myself urged at length on the consideration of geologists (see pp. 265-275 of my work on Volcanos, Longman, 1862), adding that, in my opinion, the existence of such vesicles, side by side, or even one above the other, —sometimes solidified by increase of pressure, then again, perhaps, liquified by its diminution, or increments of caloric reaching them laterally or from beneath by conduction, will account for, and, indeed, is proved by, the phenomena of volcanos, earthquakes and superficial elevations and depressions. I do not, however, intrude on your pages for the purpose of claiming the origination of these views, so much as to call the attention of your readers to the particular point on which the whole theory hinges, namely the enormous *pressure* to which every portion of the heated interior of the globe must be subjected; and this not merely from the weight, or contraction on cooling, of its outer belt, but also from the vast internal tension of its every part, caused by its tendency to expansion through intense heat, and this whether in a solid, fluid, or gaseous state. More particularly must such tension be intensified if, as there is every reason to believe, the subterranean matter is permeated with water, perhaps occasionally solidified by pressure, although at the highest conceivable temperature.

This consideration seems to have been entirely overlooked by those who have supposed the earth's interior to be necessarily fluid, because at a temperature exceeding that which would reduce to fluid fusion in open air all the materials of its outer crust. Let this tremendous pressure be locally relaxed by the fissuring and elevation of the resisting crust, as has evidently happened along the lines of mountain chains, and portions of the solid mass below must immediately pass into the fluid state—giving rise to the igneous intrusive rocks so generally found within and beneath them, "and the water contained in them, assuming as it ascends a gaseous state, will, under favourable circumstances of facility of exit, cause that ebullition of lava in which a volcanic eruption essentially consists."

This last passage I extract from another paper in your last number by Mr. Fisher (p. 493), who speaks of his view as for the first time proposed, and does not seem to be aware that this precise theory of the nature of Volcanic and Plutonic action is not only fully developed in the last edition of my work on Volcanos, but is to be equally found in that which bears the date of 1826.

In pp. 277 and 287 of the second edition I have shewn how the expansion of subterranean matter must occasion prolonged fissures through the overlying rocks, by which the intumescent matter will often find a vent, sometimes thrusting up the rocks on either side in dislocated or crumpled masses, owing to the squeeze or jam occasioned by lateral or rather diagonal pressure; sometimes, where the heated matter has risen sufficiently to communicate with the open air, ejecting it in floods of lava and explosions of steam. Hence the general parallelism and occasional coincidence of linear Volcanos and of mountainous elevations; the intervening flatter areas between these eruptive ranges undergoing at the same time either a more gradual elevation like a *creep*, or, more frequently perhaps, slow subsidence. The cause of these local changes being the transmission of heat by conduction from one part to another,—"the tendency of heat to seek an equilibrium being as much a law of nature as of water to seek a level" (p. 267, Volcanos); and the disturbance of its equilibrium arising not merely from the outward radiation of heat into space from the earth's surface, but also probably (as suggested by me in 1825,[1] and subsequently by Mr. Babbage[2]) from the pressure and accumulation of vast thicknesses of nonconducting deposits in the depths of seas and oceans.

I am gratified to find that these views as to the nature and *modus operandi* of the subterranean agents of change in the earth's crust, which I published more than forty years back, are now becoming recognized as true by many—perhaps the majority of geologists—more especially as respects the large part played in these movements by the water contained in the interior heated matter which eventually on its superficial cooling forms the substance of all hypogene rocks. For entertaining this view, I was at that early period subjected to much ridicule, and my arguments generally disregarded. There remain, I think, but two other portions of the theory advanced by me, at the early period I have mentioned above, of considerable importance, to which the assent of geologists has not as yet been given, namely, the suggestions—1st. That when the heated and liquefied mineral matter has forced its way upwards through some fissure into open air, it has rarely been in a state of true fusion, but generally semi-crystalline; and that it has cooled and hardened outwardly on exposure, not so much as melted metal cools and hardens, but rather by the rapid escape, through pores or in ascending bubbles, of its interstitial water, flashing into steam as the internal pressure diminished (p. 115, Volcanos). 2nd. That the internal differential movements of the subterranean mineral matter, while under enormous irregular pressures, and changing at times from a solid to a fluid state, and probably back again to crystalline solidity, through every intervening phase of viscosity, must of necessity have frequently arranged and re-arranged the component crystalline or semi-crystalline minerals—sometimes in irregular composition like that of granite, diorite or trachyte—sometimes in laminar or schistose bands like gneiss, mica-schist, and other metamorphic crystallines.[3] I hope the time is not distant when these opinions likewise will obtain the assent of geologists.

FAIRLAWN, COBHAM,
November 15, 1868.

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[1] Volcanos, ed. 1825, p. 30, and ed. 1862, p. 271.

[2] Geol. Proceed. vol. ii. p 72.

[3] See p. 283-290, above cited vol., and of the Geologist, vol. i. p. 361.

[See also Letter by Mr. J. Clifton Ward, on the "Internal Fluidity of the Earth," p. 581 of this present number.—EDIT.]

II.—ON THE CURVATURE OF THE TUSKS IN THE MAMMOTH, *ELEPHAS PRIMIGENIUS* (BLUMENBACH).[1]

By HENRY WOODWARD, F.G.S., F.Z.S., &c., of the British Museum.

[PLATES XXII. AND XXIII.]

THE object of this paper is to call attention to the magnificent head of the Mammoth, discovered by Antonio Brady, Esq., F.G.S., of Maryland Point, Stratford, Essex, in a brick-pit at Ilford, in 1864, and now placed in the Geological Department of the British Museum.[2]

This remarkable fossil still remains quite unique, no other skull having ever been exhumed in anything like a perfect state, owing to the very friable and perishable condition in which the bones are found in most of our river-valley deposits.

But the immense number of molars met with, and also of more or less entire tusks, attest their former numerical abundance.

Mr. Antonio Brady has lately obtained four almost entire tusks of the Mammoth, from the same pit which yielded the head, and he has, in his collection, tusks and molar teeth of elephants of all ages, from the milk-molars of the calf, a year old, to the remains of such veterans as that figured in our plate.

All the larger of Mr. Brady's tusks, also those from the Rev. J. Layton's collection, dredged off Hasboro', on the Norfolk coast, and the very perfect tusk found in a gravel-pit south of Spalding, Lincolnshire, agree exactly in their general curvature, as do also the specimens in the British Museum from Escholtz Bay and Siberia. and these likewise correspond with the tusks of the Ilford cranium, the left tusk of which still remains in the alveolus.

The drawing of Adams's Mammoth, found in Siberia in 1799,[3] well known from Mr. Waterhouse Hawkins's clever diagram, has the extremities of its tusks curved in a competely reverse direction to that of our British example.

Dr. Tilesius observes (*op. cit.*[3]), "The Mammoth is distinguished from the African and Indian Elephants, by the teeth, and by the size of the tusks, which are from ten to fifteen feet long, much curved, and have a spiral turn *outwards*. The alveoli of the tusks are also larger, and are produced further."

In Benkendorf's graphic narrative of the finding of an entire Mammoth, in a half-frozen condition, in the river Indigirka. in 1846 (noticed by Mr. W. Boyd Dawkins in a paper "On the Range

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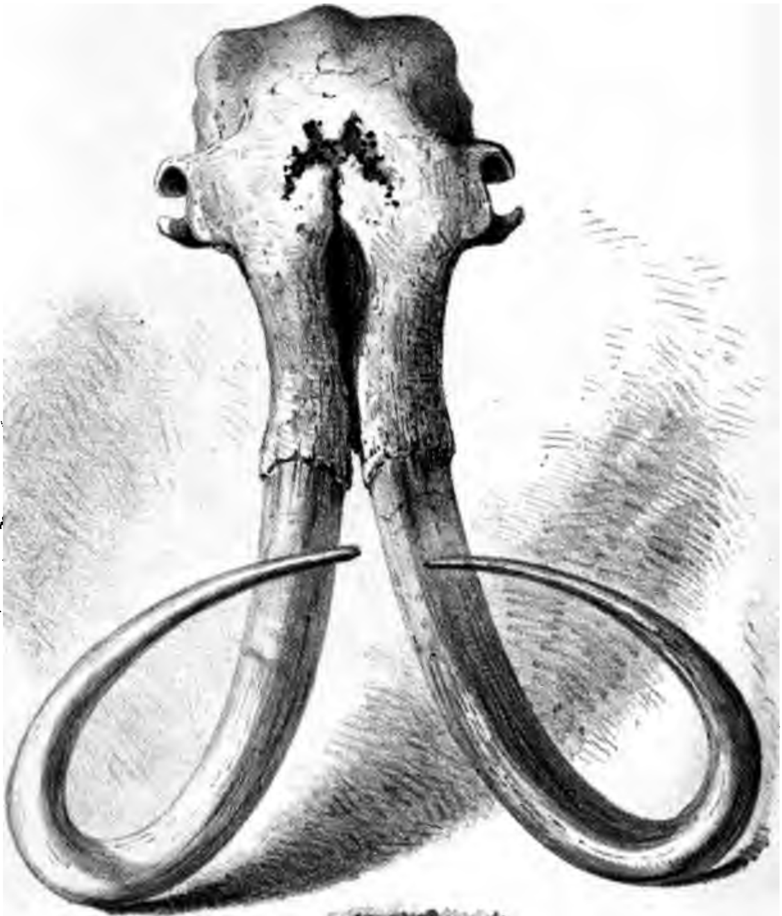
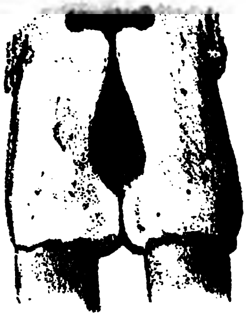
[1] The substance of this paper was read before the International Congress of Prehistoric Archæology (Third Session), Norwich, August 25, 1868.

[2] A brief account of this specimen appeared in Vol. I. of the GEOLOGICAL MAGAZINE, 1864, p. 241, accompanied by a wood-engraving, representing a side-view of the skull, with its one attached tusk. The specimen was not, at that time, set up in the gallery, so that the artist was unable to obtain a favourable view of its peculiar features.

[3] Figured in the Memoirs of the Imperial Academy of Sciences of St. Petersburg, vol. v., and in the abridged English translation of Dr. Tilesius's paper, printed in London, in 1819 (Select Strzelecki Edition).

1



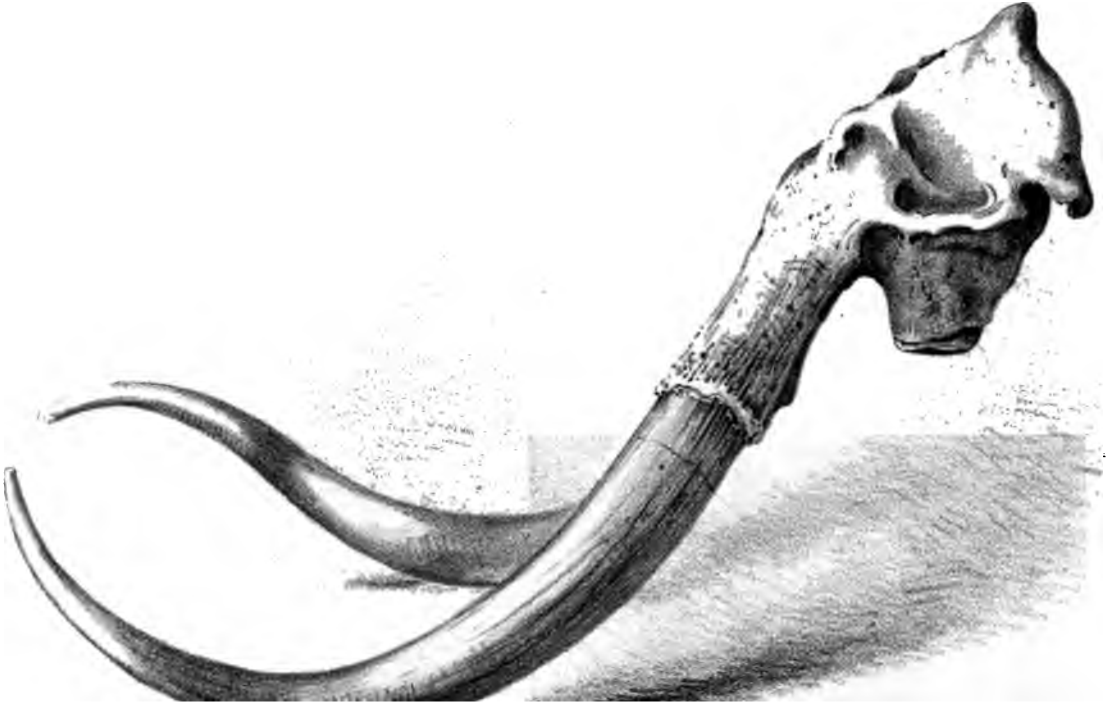


2

G de Wilde lith.

Fig. 1. Skull of Mammoth from Ilford.

Mag. 1868



W. West imp.

of the Mammoth," published in the Popular Science Review, vol. vii., July, 1868) it is stated that "the tusks were eight feet in length, thick, and curving *outwards* at their ends."

This, then, was evidently (like our Ilford Mammoth) an adult and, probably, an aged beast.

It is greatly to be regretted that Benkendorf had no draughtsman with him, as the loss of the animal (through the giving way of the river's-bank) deprives science of one of the grandest relics of a former world ever met with.

With regard to Adams's Mammoth (preserved in the St. Petersburg Museum) most of the readers of this Journal will be familiar with its history.

It was discovered in the summer of 1799, half-buried in frozen soil and ice, by a Tungusian chief, engaged in seeking for 'Mammoth-horns' along the shores of the peninsula of Tamut, at the mouth of the river Lena, in Siberia.

After overcoming his first fears that the beast was an evil omen (which brought on a serious illness), his desire for gain, says Adams, caused him to set a watch on the beast until 1804, when, it being then entirely freed from the ice, he cut off its horns and exchanged them with a merchant for goods of the value of 50 roubles (=£7 18*s.* 4*d.*), the reward of five years waiting and watching!

Adams having heard of it, in 1806, in his travels, determined, if practicable, to obtain it. With infinite pains and industry he traced out the spot where the Mammoth lay, and gathered together all that remained of his prize. For, after its 'horns' had been annexed by the chief, it became common property; and first the Jakutski of the neighbourhood, with their dogs, assembled and feasted on its flesh, and then the white bears, wolves, wolverines, and foxes polished off the remainder and picked the bones, which, however, remained almost entire, being held together by their cartilages and sinews. These he carefully packed up and forwarded to St. Petersburg, a distance of 11,000 wersts (7,330 miles).

He adds: "When I arrived at Jakutsk, I had the good fortune to re-purchase the tusks." But there is reason to doubt whether Adams really did get the right tusks after all.

Professor Maskelyne, who examined the specimen very carefully when in St. Petersburg in 1865, considers that they do not belong to the skull, and that there is a disparity between the portion within the alveolus and the rest of the tusk.

There is a statement made by Mr. Boyd Dawkins in the paper already referred to in the "Popular Science Review," which I beg here to be allowed to correct.

After describing (at p. 277) the character of the Ilford deposit, and especially the layer containing the bones of Mammalia "full of the shells of *Corbicula* (*Cyrena*) *fluminalis* with the valves united, and of the common River-mussel (*Anodon*), and the land *Helix nemoralis*"—he proceeds to say: "On a continuation of the same platform, now cut away, the skull of the Mammoth was discovered in 1864, *perfect with* the exception of the tusks, which had been broken away with their incisive alveoli. That on the right side lay 20 feet away from the skull, while that on the left has not yet been discovered. Owing to the surprizing skill of Mr. Davies, the skull and tusk were taken up and re-united, and now constitute by far the finest specimen of Mammoth in the British Museum."

Now, if this were the case, the specimen in the National Collection would have no higher claim than the St. Petersburg example, to be cited as positive proof of the normal curvature of the tusks. But the woodcut given in Vol. I. of this Magazine (1864), p. 243, partly from a rough drawing made by myself on the spot, and partly from the specimen as it was lying in the mason's shop at the Museum, shows the alveolus and tusk united. The wood-engraver did not, however, reverse it, hence it appears that the *right* side has the perfect alveolus instead of the left, as now correctly represented by Mr. De Wilde in Plate XXIII. herewith. The *right-hand tusk* was the one found detached, as mentioned by Mr. Dawkins. It is placed beside the torn alveolus, as Mr. Waterhouse was disinclined to restore it; the artist has, however, represented the right-side as restored in Plate XXII. The left side was that exposed in the pit and was quite entire, save the zygomatic arch, which was probably broken by the workmen before our arrival.[1]

In order to remove the vast and elongated mass of friable materials, it was found absolutely necessary to saw off the left attached tusk, about 6 inches below the alveolus, but the parts were again brought into normal contact in their true position after they had been placed in the gallery. The left alveolus was never broken, and the curvature of the socket, as well as of the tusk itself is therefore genuine and natural.[2]

A reference to Plate XXII. will show that there is a natural bend in the alveoli, and it would therefore be impossible to thrust a left-hand tusk into a right-hand socket; but if the tusks were sawn off *below the alveolus* then the lower portions might be transposed, and so placed as to have an outward curving extremity.

It is possible that Adams may have really obtained the actual tusks belonging to the skeleton of the Mammoth which he found. but not having seen them when attached to the animal, the tusks may have been placed in contact with the wrong sockets.

We know that the Ilford specimen was that of an aged individual, by its having cut its last pair of molars, and by these having been considerably worn. The St. Petersburg specimen is, no doubt, also that of an adult.

That the tusks in the young Mammoth were directed forwards and outwards, seems certain, but in the adult they all have, near their points, an upward and inward curve.

Nor need we be surprised at this, for, as a rule, we find that the continued growth of the tusks and the horns of most *aged* animals endowed with these weapons of offence and defence, is not that best calculated to conduce to their formidable character, but the reverse. The horns of the goat, sheep, and ox, the incisive teeth in rodents, the tusks of the wild boar, &c., may be cited as examples in which the continued growth of these structures is often deleterious to the animal.

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[1] This has since been restored by modelling the right side and then reversing it.

[2] The curvature of the right tusk corresponds with the left, showing that they are from the right and left side of the same head.

What I am most desirous to point out is, that in all the Siberian remains of the Mammoth I have seen, and in the figures given in "Cuvier's Ossemens Fossiles" (4th Edition, Plate 15), there is a constant uniformity and agreement as to the curvature of the alveoli, with our Ilford specimen.

If we compare the skull of the mammoth with that of the recent Indian elephant, we find the alveoli in the former (Plate XXII., Fig. 1) diverge near the nasal aperture (leaving a deep and somewhat elliptical cavity, broadest near its upper portion, between them); whilst they converge as they extend forward, until, in fact, they commence as separate and distinct prolongations of the incisive alveoli, when they again diverge to admit of the passage of the trunk; in the latter the alveoli converge at their upper part, and steadily diverge outwards to their extremities.

In *Elephas Ganesa* (probably one of the largest of all the fossil elephants, and certainly possessing the largest tusks,) brought by Colonel Baker from the Siwalik Hills in India, and exhibited next to the Ilford specimen in the Museum Gallery, the concavity between the alveoli is broadest at the lower part of the premaxillary bones, becoming narrower upwards until, near the nasal orifice, the alveoli are in contact. See Pl. XXII., Fig. 2, which represents the alveolar portion of this fine skull.

In "Cuvier's Ossemens Fossiles" already referred to (Pl. 15), two figures are given of two skulls from Siberia; one an upper view, the other an under, or palatal aspect. These have a precisely similar curve to the alveoli, as depicted in Plate XXII., Fig. 1.

Any tusk having the alveolar end preserved, can be determined with great certainty as to which side of the head it should be referred, by carefully noticing its curvature.

In calling attention to the fine series of Elephantine remains chiefly from Britain, India, and Siberia, preserved in the National Museum, we cannot fail to recall the loss of that great and able naturalist, Dr. Hugh Falconer, whose work especially lay among these fossils, and whose labours and those of Sir Proby T. Cautley, in the Siwalik hills, have tended in so great a degree to enhance the excellence of this portion of the Museum.

Nor among the names of still active collectors of these remains must we forget to mention the Rev. John Gunn, F.G.S., whose elephantine series from the Forest-bed of the Norfolk Coast now enriches the Norwich Museum; and Antonio Brady, Esq., whose collection (made with unsparing liberality to the workmen of the Ilford pits, and with every specimen rendered both as durable and as perfect as possible by the skill of Mr. W. Davies) we may hope some day to see adorn a public museum of a more or less national character.

III.—ON THE DENUDATIONS OF NORFOLK.

BY THE REV. O. FISHER, M.A., F.G.S.

A Paper prepared at the request of the Local Committee, and read at the Meeting of the British Association at Norwich, 1868.

AFTER referring to the scope of the subject which had been named by the Local Committee, the Author said—I will first ask your attention to the denudations, by land and sea, now taking place in the county.

Upon the Land Surface, a certain amount of the finer material is being carried into the rivers, and by them deposited at the heads of the broads, or, where such do not exist, in the sea. This denudation by pluvial action is undoubtedly greater where the land is under the plough than it would be otherwise.

Upon the Coast, the sea is reducing the solid surface to a uniform level. Where the land is high it cuts away the bottoms of the cliffs, which then founder down, and the fallen matter is in its turn carried off. Where the land is low, the general contour of the coast is being continued by sand dunes, or (as they are locally called) "marram hills," so that where the lower end of a valley is submerged, as behind Yarmouth, its bottom is being raised seaward, and all reduced to a uniform level and continuous coast line.

But when the waves have played their part, the action of the sea is not ended. As the waves cut further and further into the land, carrying off, as has been known to be the case, from two to twenty yards during a single storm,[1] the ground thus laid under water becomes subject to the action of the tides, and its surface is continually removed, so as to be kept on the whole at a depth uniform for a given distance from land. If the waste of the shore line is prevented by artificial means, such as sea walls or groins, then the sea is found to deepen more rapidly, and the inclination of the bottom from the shore to be increased. This has notably been the case at Walton-on-the-Naze, in the neighbouring county of Essex.

Sand and mud are, in the meanwhile, carried by the prevailing winds and currents, and arrange themselves in definite forms, more or less taking the direction of the contiguous coast, and shifting, as the shore shifts its position by the destruction of the cliffs.

If this marine action be considered, it does not appear possible that it can give rise to any very great inequalities of surface, but, on the other hand, that it must tend to reduce those already existing, whether above or below the waters. All *great* inequalities of the sea bottom must either have been caused by the land having become submerged more rapidly than the sea has had time to erode its coast-line, or else by elevations and depressions taking place beneath the ocean, or in a few instances by powerful currents confined by local circumstances to a narrow course.[2] Nevertheless, since the tides do, in fact, deepen the sea below the level to which the waves act upon the coast, it must follow that the harder rocks will be lowered more slowly than the softer, and shoals be formed.

Now it is to such a denudation as I have been describing, that we may suppose the form of surface of this county to have been due, at the earliest period to which I desire to call your attention, namely, that preceding the deposition of the Crag.

The Chalk in Norfolk dips very gently towards the east; but the inclination is somewhat increased on the western side of the county towards its outcrop,[3] so that, as seen in a quarry close to the railway station at Hunstanton, it becomes very marked, and amounts to eight or ten degrees. This brings up the Carstone (Neocomian) and the softer clays beneath. The altitude of the Chalk along the watershed of the county is considerable, but has not, I believe, been exactly determined. We may safely then suppose that the sea bottom at the period of the Crag consisted of a shoal bottom of Chalk, nearly level on the eastern side of our area, while the same stratum rose as dry land to a considerable elevation towards its central and western portions; but there is no distinct indication of the position of the ancient coast line of the Crag sea. It certainly extended further inland than

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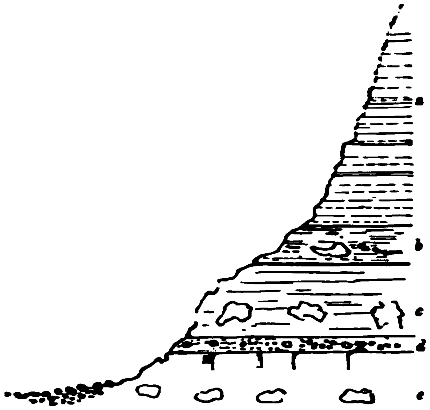
[1] For information on this point see Gunn's Geology of Norfolk, in White's History of the County.

[2] *E.g.* off the southern point of Norway.

[3] This is a very common case, and usually determines the run of an escarpment.

Norwich, Horstead, and Coltishall, and I see no reason to doubt that the remnants of ferruginous shelly gravel adhering to the surface of the Chalk on the beach at Lower Sherringham belong to it.



Section at the base of cliff at the first point west of Lower Sherringham.

a. "Laminated beds," sand, gravels, and clays.

b. Ferruginous gravel cemented by iron oxide; a piece of deer's horn was found in it. Probably the Elephant bed. 2ft. 0in.

c. Blueish grey sandy clay, micaceous, and containing drifted lumps of the same. Probably the Forest bed. 2ft. 6in.

d. Ferruginous pan, with large flints and abundance of *Cyprina Islandica*. Probably Norwich Crag. 1ft. 6in.

e. Chalk rising above the beach. 1ft. 6in.

N.B.—This is the most complete section which I have seen, and if the strata are correctly determined, it shows the entire sequence.

The appearance of the chalk at Bungay, and of the Upper Norwich Crag at Aldeby, near Beccles, would lead us to place the junction of the two deposits somewhere between Beccles and Bungay,[1] and it may be remarked that, on account of the low level always occupied by the Crag, there is reason to believe that when we approach the boundary of that formation, we are in the neighbourhood of its veritable coast line. Moreover, the abundance of the bones of gigantic proboscidians, found at Horstead and Norwich (but especially at the former place) among the flints which constitute the base of the deposit, prove that at those points the land could not have been far distant. We have no data at present, that I am aware of, for determining the nature of the coast line of the Crag sea, but it was probably a line of cliffs extending in a direction somewhat parallel with the present eastern coast of Norfolk, and about twenty miles westward of it.

In the neighbourhood of Yarmouth, however, a different condition of things must have obtained; for there the London Clay covers up the Chalk,[2] and owing to the softer character of that stratum, it is probable that the sea was deeper over it, and the Crag deposit probably somewhat modified in its character.

Indeed there seems to have been from early post-Cretaceous times a depression of erosion in the course of the valley now occupied by the Waveney and Little Ouse, which separates the counties of Norfolk and Suffolk. In the well section at Diss, given by Mr. Gunn,[3] 200 feet of superincumbent strata were pierced before the Chalk was reached, and then only 330 feet of chalk-with-flints were found remaining; whereas at Norwich 1050 feet is the thickness of that bed. At Yarmouth the Chalk was not passed through, so that we learn nothing from the sinking there respecting an early excavation of the Chalk.

[1] See Trimmer's Geology of Norfolk, Jour. of R. Agricultural Society, vol. vii., p. 449, note.

[2] Prestwich, Quart. Jour. Geol. Soc., vol. XVI., p. 449.

[3] Geology *of Norfolk, p. 7.*

But the well at Yarmouth proves that the erosion
during the Eocene period was again repeated in lat
beneath the sea-level being now occupied by very lat

We have no evidence that the sea of the Crag peri
present estuary of the Wash. It is probable on the o
have extended considerably to the westward of its
reasons seem to favour this idea. In the first place
debris of both the upper and lower beds of the Cha
deposits, showing how much has been destroyed ;
general depression of the surface, which would have
gence of the Crag beds to the probable depth at whi
feet or so beneath the sea, would allow nearly 200 fe
added to the Chalk, without its forming higher land d
does at present. This would manifestly bring the es
west of its present position, without its forming more
now.

Immediately upon the Chalk at Thorpe, and more
where the Crag rests upon it, there lies a thick bed of
rolled, but appear to be the accumulated result of the
vening between several successive layers. In a lar
observed a band of flint *in situ* in the Chalk, croppin
integral portion of this remarkable deposit. It is
numerous bones, teeth, and tusks of Mastodon and
other mammalia occur. I believe they are more num
where. The interstices of this bed are filled with s
of them, in their natural positions with valves united,
especially at Thorpe. My belief is that the Chalk to
was removed by the erosion of currents, which were
the flints; but sweeping in among their interstices,
gradually eroded the softer Chalk. Nevertheless, if t
difficulty in accounting for the bones being buried an
alternative that the Chalk formed a land surface,
left, the flints being accummulated by subaerial solution
greater difficulties. For it is hardly possible to con
taken place over so wide an area, without the formati
quent entire destruction of the old surface. And even
introduction of the united valves of mollusks throughou
less difficulty than that of the bones on the other sup
subaerial condition would have been accompanied by p
occur of that particular date. And also the bones oug
of the stratum, which I believe is not the case.

We have now arrived at a period in the Geologic
presents among many intricate problems one of the
succession of events subsequent to the period of the Cra
this question is the position of the Chillesford clay. I
be excused if I say a few words upon that point. I
an opinion that the Chillesford clay is older than the
quent observation led me to recant that opinion,[1] and
Messrs. Searles Wood, that the Norwich crag is the lo
that the shell bed at the base of the Chillesford clay,
bourne Church Walks, Easton Bavent Cliff, Aldeby, a
than the Upper Crag, distinguished and described by
Bramerton, and other localities in this neighbourhood.
itself is very changeable, often passing suddenly into sa
usually fine micaceous grey clay. This variable cha
section in a rickyard between Surlingham Ferry and B
I adopt the view of the Messrs. Wood regarding the se
Chillesford clay to the Crag (whether red or fluvioma
position relative to the Forest bed, and the Glacial seri
made out. Mr. Searles Wood, jun., tells us shortly,

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[1] Jour. Geol. Society, vol. xxiii. p. 175.

[2] Wood on the Red Crag. Quart. Jour. Geol. Soc., vol. xx

section appended to his father's paper, that the Forest bed, and gravel containing fluviatile shells and mammalian remains, are probably the equivalent of the beds of his section from d^1 to f. Now the beds thus indicated include the Red and Norwich Crag, the Chillesford clay, and what Mr. Wood calls the Bure valley beds, which are a part of Mr. Gunn's "Laminated" series, or 3^1 of Sir Charles Lyell's section in "The Antiquity of Man." In other words he looks upon these deposits as a terrestrial equivalent of the above marine series.

Mr. Gunn, whose opinion on all points connected with the geology of the county is of great weight, read a paper before the Norwich Geological Society in November last, from which it appears that he considers the bed of flints with bones of mastodon, lying upon the Chalk, to be alone worthy of the name of Mammaliferous Crag, and that he entirely dissociates from it, in respect of age, the shelly sands which at Thorpe and elsewhere cover it. He would intercalate the Forest bed in time between this bed of flints and the shelly white crag sand, and continue the sequence upwards with the Chillesford clay, and next the Laminated fluvio-marine series, or 3^1 of Sir Charles Lyell's "Antiquity of Man."

Mr. Prestwich during the discussion upon his second paper on the Crag, read at the Geological Society in May, mentioned that he had found what he considered traces of the Forest bed in Eastern Bavent Cliff, above the Chillesford clay, and as he thought indications of the same sequence in the upper part of the cliff at Walton-on-the-Naze. Here then are three distinct opinions put forward by three geologists, more competent, perhaps, than any others on this question. For my own part I lean to Mr. Prestwich's view, and chiefly for this reason.

During the Crag period we have two proboscideans abundant—the *Mastodon Arvernensis* and the *Elephas meridionalis*. As Mr. Gunn informs us,[1] the mastodon and that species of elephant occur together in both the Red and Norwich Crags, but in the Red Crag the mastodon is more abundant than the elephant, while in the Norwich bed their proportions are nearly equal. The *Elephas meridionalis* is continued into the Forest bed, but the mastodon disappears, other species of elephant coming in to make up the tale. If, then, the mastodon occurs in the Chillesford clay, and the associated upper Crag or *Mya* bed, that seems to me to afford a strong presumption that the Chillesford clay is older than the Forest bed. Now there are two instances of well-authenticated finding of the mastodon in the cliff at Easton Bavent. One was the tooth of a young animal, which was dug out by Mr. Ewen, of Southwold, from the Upper Norwich Crag, or *Mya* bed. I have seen this specimen, and have a letter from Mr. Ewen in my possession describing its *gisement*. The other was a portion of a jaw, with a tooth in it, the finding of which, half way up Easton cliff in a fallen mass, is described in a letter from Colonel Alexander to Mr. Wood, of which, by that gentleman's kindness, I possess a copy. It must be understood that this was not the tooth picked up near Sizewell Gap, which is figured in Owen's "Fossil Mammals" as from Colonel Alexander's collection. The specimen alluded to fell to pieces. It is perfectly true, as Mr. Gunn has pointed out to me, that a bed of clay, extremely like the Chillesford clay, occurs at the base of the Norfolk cliffs in the lower part of the Laminated series, but I do not think that lithological character is a reliable guide in the present case. A bed of clay in that position could hardly fail to have the Chillesford character, but I have seen nothing there at all similar to the Chillesford fossils.

There is another supposition, which appears to me worthy of investigation, and that is whether the Chillesford clay may not be a continuation of the lower portion of the soil of the Forest bed. The occurrence of whales' bones in the clay at Chillesford, and also in the soil of the Forest bed, is a remarkable feature of resemblance, and this supposition would intercalate the Chillesford clay in what appears to me to be its most probable position, intermediate between the Crag and the Forest bed.

At any rate the sequence of events introduced the deposition upon the Crag of a fine clay, most probably formed in an estuary open to the Northern Ocean. To this estuary whales had access, and there is much reason for supposing that it was no other than the estuary of the Rhine, and of the Thames, and other rivers which formed tributaries to it.

The sides of this estuary next became dry land, so as to allow of the growth of

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[1] *Norwich Mercury*, Nov. 9, 1867.

the forest upon the old muddy bottom. To discuss th
beyond the province of the present paper, but I am ir
or at any rate one affecting so large a portion of the ea
left any traces of its occurrence in local faults, or app
strata.

There is reason to believe that the elevated conditior
lasted for a long period, and it seems from the fauna of t
synchronous with a warmer climate, than that which pr

I am unable to describe the condition of the Forest
tion, since it has never been uncovered, when I have v
tion of a Forest bed, which is always to be seen ne
bably, I think, belong to another and much later pe
of the old forest, as it appeared in the winter of
indurated gravel, and occasionally the argillaceous
hardened by oxide of iron, were found to lie in low rid
six feet above the ordinary level of the Forest bed, and
arrangement, I should conjecture, was owing to the di
or cementing matter determining the undenuded par
beach, he adds, was seen to be twisted and contorted in
ner, lying in the space of 20 yards in every possible
broken into fragmentary masses. But so far from bei
denudation suffered by this deposit as seen upon the
any of it remains; and if the area where it is seen
land, so that in the process of going down (or possibly
river breaking its banks in times of flood), it had becom
sand and silt, when the sea water was admitted afterwa
swept away, as the water gained upon it. For an expa
rate size gets up breakers on its shores, and these cut
traces of its original subaerial surface become oblite
sinking area this process must continually go on as the
further upon the land, unless the land should go down b
and the sea flow over it before the waves have had tim
Indeed, I should suspect that this result of a sudden i
occurred in the present case, not by a paroxysmal sinki
destruction of some seaward barrier, which converted
land, and next a freshwater lagoon, into an estuary.

It is probable that the Forest extended towards the Ch
soil of clay extended, but from the causes just explaine
vestiges of it would always be preserved. Indeed, to
denudation, the only conditions under which vegetable
parts of animals, can long resist decomposition, is by t
covered with clay.

Hence as the land continued to sink to a lower and l
strata of sands, clays, and gravels would accumulate an
Forest bed would not be preserved beneath them, exce
had become submerged before the area communicated

If it be asked how far the waters extended which drif
the position now occupied by them, I am not aware th
ground of answer. But their close relationship to the
in time, because the forest intervened,) would lead one
differed little from the coast line of the Crag, though it
somewhat further upon the Chalk land.

Subaerial denudation must necessarily have been goi
during the period of the Forest: but all records of it mu

The great Glacial series of deposits follows next in asc
of these I shall adopt Mr. Searles V. Wood junior's di
and Upper Drift; and I am bound to say that I believe
service to Geology in making out their sequence, and
the three members of that great formation.[1]

[1] Messrs. Wood and Harmer subsequently read an elaborate
glacial structure of Norfolk and Suffolk. See an abstract Geo

The lower Boulder-clay overlies the laminated beds. But during the interval between them the sea must have become much deeper, and have been now involved in a system of extensive tidal currents.

Ice capable of transporting mineral matter and depositing it at the bottom of the sea occurs under two modifications,—as icebergs and as coast ice. Icebergs receive the principal part of their freight while in the parent glacier, partly from rocks falling on them, and partly from debacles from lateral valleys,[1] and occasionally, after they become detached, by approaching close to cliffs and receiving falls from them.

Coast-ice is that which forms by the freezing of the surface of the sea along the shore. It is attached more or less to the land, and in that respect differs from pack-ice, which is formed on open water. By pressure taking place among coast-ice, heaps of shingle, sand, and mud are formed, to which the ice becomes fixed, and the whole floated away. But a most important mode by which mud is collected upon shore-ice, is when the thawing snow of spring brings down quantities of mud from the land[2] and spreads it out upon the coast-ice before it breaks away. When this afterwards takes place it is carried into deeper water and there deposited.

It is clear that the deposits of small material from all these causes will take a roughly stratified arrangement, such as we see in the lower Boulder-clay; and the smallness of the boulders contained in it and its gradual deposition appear to point to coast-ice as the instrument of its formation. By coast-ice, also, the few shells which it contains were picked up from off the shore. Some portions of the mass have doubtless come from far, but probably the greater portion of it from near at hand. In a fragment of this stratum which remains in the upper part of the brickpit near the Norwich ferry, the clay seems to be chiefly derived from the London clay, and contains numerous Eocene pebbles.

What appears to be this lower Boulder-clay may also be observed in the low cliff immediately above the Railway Station at Hunstanton, while a section given by Mr. Rose[3] proves that it extends to Lynn, where it rests on the Oxford clay.

Hence it seems that the area of the Wash, and of the low lands of part of the Bedford level, were occupied by the sea in the early part of the Boulder-clay period. It is on account of the antiquity of these master valleys that the lower Boulder-clay takes the form of a coast deposit, owing to its low position, and this gives it the (as I believe) fallacious appearance of bearing to the Upper Drift the same relation that the low level gravels are supposed to bear to the higher, the lower being the newer of the two.

I am not aware of there being any decided proof whether or not the Chalk land was covered by the sea at this period; for I do not know that we find the lower clay reposing upon the Chalk in any of the higher parts of the county.

The occupation of the sea by coast-ice, to the exclusion of large bergs, points to a condition of shallowness, and to a freedom from the currents of an open sea. When the sea became deeper bergs might be expected to be introduced, and accordingly we find unmistakable evidence of their action towards the close of the deposition of the Lower Drift.

I believe that that deposit had been a gradual and a tranquil one, and from some change in the mode of deposition, possibly from an amelioration of climate, it had become more sandy and more regularly stratified in its upper part, and that at that period the sea had attained a considerable depth. Then the period of the Middle Drift set in. Larger masses of ice, loaded with heavier freights of sand, and gravel, and chalk, were introduced, and by their falling upon the previously horizontal strata, those contortions were formed which at first sight appear so perplexing in the Cromer cliffs.

Let me request your attention to the *modus operandi*. If a mass of material is spread out equably over another, both being in a plastic state, the surface of their junction will be horizontal. But if a quantity of one such material be dropped upon a limited space of the other, it will sink down into it, and the depth to which it sinks will depend upon the quantity which falls. The material of the lower stratum, which is squeezed aside by the intrusion, will be driven into folds all

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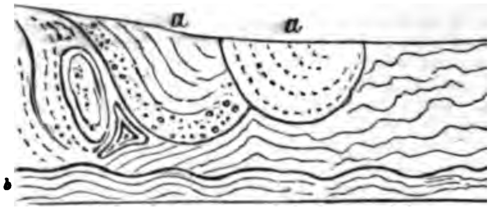
[1] Sutherland's Journal, vol. i. p. 127.

[2] Ibid. vol. ii. pp. 182, 198, and Journ. Geol. Soc. vol. ix. p. 308.

[3] Geology of W. Norfolk, Phil. Mag. vol. viii. p. 35.

around the area invaded by the foreign mass.[1] This
of the anomalies of what has been called the conto
siderable contortions occur, they will be found connec
mass of sand, or gravel, or chalk, or of some matter
clay which is thrown into contortions. When the ma
has sunk down through, not only the upper but also
Boulder-clay, and in one case I noticed that it had
the laminated beds beneath.



a. a. Two masses of Gravelly sand dropped upon the Lower
right and left, and contorting even the laminated be
affected in that way. Cliff between 30 and 40 feet hi

Very often the mass which has fallen has evidently
that its parts have maintained positions which they co
served. For instance, I noticed one mass in which w
mud, its surface in a vertical position, and the ripple
75° to the horizon. Nothing is more common than to
sand in all kinds of positions inexplicable on any other
were solid masses at the time they fell. Now that such
only possible but certain. If a frozen mass, consisting
the form of sand, clay, gravel, or stone, be just capa
matter cannot exceed about one-twentieth in bulk
moment that, by the thawing of the ice, the ratio of r
whole must immediately sink. It is true that we ma
arranged in the berg that it might all be liberated with
the infinite number of ways in which the rocky matter m
it cannot but occur that blocks of ice containing e
sink before they are thawed.

Thus, Mr. Trimmer's supposition is established, that
bedded in the sea bottom, and, by its subsequent liquefa
to produce the contortions.[3] I believe, however, that t
previously described.

In attributing contortions in the underlying beds to
matter upon their surface, I would go to the extent of
able bluffs of chalk at Trimmingham may have been up
There are two of these about half a mile distant from e

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[1] See Lyell's Principles, Vol. I., 1867, p. 447.

[2] I the volume of ice in the berg.
M ,, ,, stony matter.
W vol. of water displaced.
S the specific gravity of ice $=$ ·92.
S' ,, ,, of granite for stony matter $=$ 2·5.
1 ,, ,, of Water.

Then because the mass floats $S\,I + S'\,M = 1\,W$, and beca
that it has no part above water, $I + M = W$.

$$\therefore (S-1)\,I + (S'-1)\,M = 0$$

$$\frac{I}{M} = \frac{S'-1}{1-S} = \frac{1{\cdot}5}{{\cdot}08} = 19 \text{ nea}$$

$$\text{Hence } \frac{M}{I+M} = \frac{\text{stony matter}}{\text{whole mass}} = \frac{1}{20}$$

[3] Journ. Geol. Soc., vol. vii, p. 22.

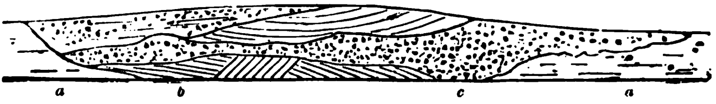
tween them exhibits chalk at low water, consisting of identically the same beds as those constituting the bluffs, and one of these beds is very marked from the abundance of a small oyster.[1] The chalk on the shore is even more disturbed than that in the cliff, some of it standing at a very high angle. But what is especially worthy of remark is that the Boulder-clay also appears on the shore, intermixed with the Chalk, and partaking of the same contortions. At one place a very distinct synclinal was observed, where the Boulder-clay was invested on three sides by Chalk. I conceive the elevation of these great masses of Chalk to have been due to a kind of creep. But there are other features about the bluffs which are very puzzling. One of these is the cavities they contain, filled with stratified alternations of calcareous sands and carbonaceous matter, evidently of ancient date. These cavities led me to suppose these masses might have formed needles or rocks in the Glacial sea. But, if so, it is difficult to conceive how the large flints, usually covering the Chalk surface, could have been preserved upon their upper parts *in situ*, as they are.

During the period of subsidence—intermediate between the deposition of the Lower Boulder-clay and middle Drift of Mr. Wood, when those deposits were formed, which he distinguishes by the letters *i*, *k*—it is probable that a great amount of denudation took place upon what is now the Chalk district of Norfolk.

Mr. Trimmer places the "reconstructed Chalk" in this period, and I agree with him, differing from Mr. Wood, who fixes it at an earlier period. But in using this term, "reconstructed Chalk," I must guard myself against being misunderstood.

Norfolk geologists are accustomed to speak of the disintegrated, and somewhat deranged, Chalk in the upper portions of their vast chalk-pits, as "reconstructed Chalk." The examples which have been pointed out to me, as, for instance, that at Eaton, to which I was conducted by Mr. Taylor, I believe to be nothing more than Chalk disintegrated *in situ* by the percolation of atmospheric water.[2] But on the north-eastern boundary of the Chalk area chalky matter in a very different condition is to be met with. It is to be seen in a very typical form about Kelland and Weybourne. The chalky loam is usually cream coloured, and is much of it horizontally stratified, and contains thin bands of sand and laminæ of mica. This is especially notable in a pit on Kelland heath. There the section of the quarry has a fine ribboned structure, observable in the smallest specimens, exactly like some of the ribboned layers of a fresh-water deposit (the Purbeck beds, for instance). The planes of division contain much mica. The formation of this loam is easily explained, by conceiving icebergs to have stranded upon the shoal of Chalk, the margin of which extended to this place, and grinding over the surface under the action of winds and tides, to have raised clouds of chalky mud, which, mingling with the foreign material from the berg itself, settled at a lower level, in horizontally bedded loam, around the confines of the shoal.

The deep channels cut out of the chalk surface by these bergs, are to be found further to the west. There is a splendid section of such a one in the railway cutting between Holkham and Wells. The width of it is 120 yards. It is filled with coarse bouldered gravel, and fine calcareous sand, containing abundantly fragments of chalk foraminiferæ, and occasionally a fragment of the *Cardium edule*.



Railway Cutting west of Wells, Norfolk. Length 100 yards, height 25 feet.

a. a. Chalk *in situ*.
b. False bedded calcareous white sand, consisting largely of minute organisms of the Chalk with an occasional fragment of *Cardium edule*.
c. Very coarse bouldered flint gravel, with subangular lumps of Chalk.

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[1] Mr. Seeley considers it to be probably *Ostrea acutirostris* (Nills), common in the lower Chalk of Cambridgeshire.

[2] There is reason to think that this disintegration is sometimes very old, if not Pre-glacial and of the age of the Forest bed, owing to the remarkable cervine remains accompanying it, as at Whitlingham.

Here we have the coarser materials from which
carried off to form loam elsewhere (an ancient man
magnificent scale).

The occurrence of masses of glacial materials in is
as for instance at Gallows Hill, on the side of the C
and in a pit just beyond Harford Bridges, on the
may, I think, be referred to this kind of action and t
to find that the conclusion I came to upon the groun
structed Chalk agrees with Mr. Trimmer's, who plac
is the Middle Drift of Mr Wood. The denudation to
been subjected during the period of the Middle Drift,
ing, must have been enormous. Bear in mind how sma
Chalk is formed of flints, and then consider the imme
coarse and fine, derived from chalk flints, out of whic
the thick and extensive outspread of the Middle D
gravels of many parts of Norfolk, as I am informed
of flints, containing a peculiar sponge, occur. I hav
dance in the coarse bouldered gravel overlying the Lo
Now the bed of Chalk containing these flints is nowh
shore, and in the remarkable bluff already alluded to
where else that bed of Chalk has been denuded, and mu
during the period of the Middle Drift.

It is in the lower part of this middle member of th
great bouldered flints principally occur. They are mi
may be seen in the pit at Wayford Bridge, and many
lofty cliffs at Beeston and Beacon hill, and cover the
ranges round Cromer. Mr. Wood's opinion is that this
formed during an amelioration of climate.[2] Mr. Trim
an examination of the soundings recorded in Polar v
Sir Edward Parry, proves that in frozen seas, mud, whi
is regarded as a deep water deposit, is characteristic o
sand and shingle would prevail in other seas.[3] Though
appears intended to be asserted.

I think we may say that very little beyond its geogr
about this stratum. I lived upon it in Essex for sever
ing a variety of pebbles from the old rocks, and one
learn little definite about it. I once found a few fragm
of a *Tellina*, from a sand pit in the valley at Hoxne,
position seems to belong to the Middle Drift. At a pi
called Firgrove pit, a sand occurs, which appears to
contains foraminiferæ, derived, as Mr. Taylor tells m
Boulder-clay. The former appear to be of the same s
railway cutting near Wells. We owe almost all the de
about the Middle Drift to Mr. S. V. Wood, jun. He see
sea, which deposited it, did not cover the highest lan
lowest beds in Norfolk, forming the crest of some of th
ern part of the county, and I think it is exceedingly pro
whole Chalk area.[4]

There are patches of Boulder-clay, as for instance
places around Norwich, which are believed to belong
the Middle Drift must have been greatly reduced in thic
they were deposited, or else it must have been original
than where normally developed.

The Upper Boulder-clay or Upper Drift was first dis
by Mr. Searles Wood, jun.[5] It is that stratum which,
and great superficial extent, deserves the name of *The*
Norfolk now covered by it is, however, comparatively sm

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[1] Geol. of Norfolk Jour. of Agr. Society, vol. vii., p. 463.

[2] Remarks in explanation of Map of Upper Tertiaries, p. 12.

[3] Journal of Geological Society, vol. vii., p. 21.

[4] Sands were seen about Docking on high Chalk land, which a

[5] Remarks in Explanation of the Map of the Upper Tertiaries

an extensive spread. Since the whole of the area of Norfolk was probably deep beneath the ocean which deposited this clay, and denudation consequently almost suspended, our great ignorance of the period in question does not greatly affect the subject in hand.

The researches of Messrs. Wood and Rome in Lincolnshire and Yorkshire[1] have, however, thrown some light upon the series of deposits subsequent to the Upper Boulder-clay of Norfolk. The transport of ice-borne materials appears by no means to have ceased with the Upper Drift of Norfolk. That deposit becomes a fresh point of departure, and is described by them as the *basement* Boulder-clay of the adjoining county. There it is on the eastern or seaward side of the Wolds overlaid by another Boulder-clay containing Chalk pebbles in much diminished abundance, and called by them the Purple-clay. Patches of the same clay on the northern and western confines of Yorkshire prove that that clay, though now generally denuded, once extended considerably to the north-west of its present boundary. This clay occurs on the summit of the Chalk escarpment at a height of 400 feet;[2] and the authors conclude that the entire absence of Chalk in its upper portion is due to the submergence of the entire Chalk range under a very deep ocean. There may, I think, be another explanation of this fact; for it does not follow that glacial conditions must prevail wherever glacial deposits are carried; and yet again, a glacial envelope of a land surface is not a necessary consequence of a very cold climate, great precipitation being also a requisite concomitant condition.[3] Either of these suppositions might perhaps explain the absence of Chalk debris in the Purple-clay without necessitating the immense submergence supposed.

Having thus traced the changes, with their accompanying denudations, which built up the series of deposits between the fundamental Chalk of Norfolk and its Upper Boulder-drift, and having pointed out from a reference to the work of Messrs. Wood and Rome that there was probably a still further accumulation of material, of which no remnant now remains in this county, I am next called upon to suggest the means by which an immense quantity of these accumulations has been removed, and the surface reduced to the undulating form which now obtains.

There are, then, two grand points for consideration in this problem. First, the removal of material, and secondly the formation of contour.

But the formation of contour is due to the removal of material; and hence the question arises whether the same agencies which have produced the present contour have removed all the material. Have the Purple-clay—which probably covered the Upper Drift of Norfolk—and the Upper Drift, and the Middle Drift, and the Lower Drift, been all denuded from the Chalk hills of this county by the same agency which gave them their form, and carved out the valley in which we are now assembled. It is demonstrable that such was not the case.

Almost all geologists of the present day agree with Hutton and Playfair that the winding valleys, and gently swelling hills, were not shaped by ocean waves and currents. They are the result of subaerial as distinguished from submarine denudation. But the whole pile of rocks, out of which they have been formed, was once beneath the sea. The land must have been raised, or the ocean lowered, before subaerial denudation could commence. During that process, whether it were short or long, marine denudation must have taken place. Hence the questions are how much of it was due to the sea; and how did the sea act. I believe it may be accepted as an axiom that under any given circumstances, whether of submarine or subaerial denudation—that is, in all cases where the movement of material is effected by the combined action of the pressure of moving water and gravity—a state of comparative, not absolute, equilibrium will be soon attained. But when an alteration of the relative levels takes place, producing a shallowing of the sea, or an increased inclination of river courses or glacier beds, the eroding agents begin to act at greater advantage, the condition of approximate equilibrium is destroyed, and denudation is accelerated. I need not enter into the mechanics of this. It will occur to every one considering the subject, how the currents of the ocean move more rapidly over the bottom when the depth is diminished up to a certain limit,[4]

[1] Journ. Geol. Soc. vol. xxiv. p. 146.

[2] Geol. Journ. vol. xxiv. p. 149.

[3] Sutherland, Arctic Regions, Journ. Geol. Soc. vol. ix. p. 302.

[4] But there is a point at which the friction of the bottom so checks the motion of currents, that denudation ceases, as may be seen on a low shore when the tide runs out.

and on land the streams flow more swiftly, and earthy matter is more readily movable, when the fall is increased.

If we knew the scouring force of marine currents in any locality, we could calculate exactly the rapidity with which an area might be elevated, so as to keep it just submerged. Upon this eastern coast we know the scour to be very considerable. The instance given by Mr. Gunn is much to the purpose.[1] Mr. Cubitt, of Bacton, informed him that vessels can now sail at high water, where, no more than thirty-five years ago, land was cultivated, and I have already referred to an instance at Walton-on-the-Naze, where the depth of water is constantly increasing beneath the jetty. In fact, it is self-evident that the sea over any given spot off this coast is gradually becoming deeper—in other words, marine denudation is progressing. From such considerations it would appear that the true measure of denudation is the rate of the elevation of the land (or depression of the sea) up to a certain value of that rate; so that, under favourable circumstances, submarine denudation may go on much more rapidly than we are apt to suppose.

As soon, however, as the rate of elevation begins to exceed the rate of denudation, dry land will make its appearance. And in every place where dry land exists this must have happened; and it appears to me to be an argument for much more rapid movements of the surface than we usually suspect.

Let us now trace what would seem to be the consequence of the rate of upheaval exceeding that of marine denudation among such strata as we have hereabouts. The surface, as has been shown, I believe, by Professor Ramsay, would emerge as an approximate plane of considerable extent. Inequalities would exist upon it, so that the sea would run up into inlets around the coast, and in the intervening parts the waves would commence the formation of cliffs. Now, as the elevation continued, what would become of those cliffs? Would they be raised high and dry, and form escarpments inland? I think not. As the land rose, the beach would be constantly swept away, and the cliffs would continue to be sea cliffs, being still cut back, but more slowly than if the land were stationary. Around the shores of the estuaries, however, where the force of the waves was less, the beach might possibly be raised high and dry by a rate of elevation too small to produce the same effect on the open coast. It follows, then, that the present sea cliffs will in the main be the true representatives of the original cliffs, which began to be formed when the land first emerged from the ocean. They will, doubtless, by waste have been cut back further inland, but they will be the true successors of the original cliffs.

This, then, is another argument against inland escarpments among soft strata being old sea cliffs, in addition to those which have been frequently adduced and so well collected and commented on by Mr. Whitaker.[2]

I think it by no means certain, nevertheless, that submarine erosion by currents, (not by waves,) may not have acted more readily along the outcrop of soft beds, and thus commenced the valley systems which have been intensified, and brought into their present contour, by subsequent subaerial action (using that term as the opposite to submarine). I suppose that the gravels, which may be conceived to have resulted from such action, are what Mr. Searles Wood calls in his writings "denudation gravels." But the general absence of marine *exuviæ* of every kind is a difficulty in this view of their formation.

It will be understood, then, that I should attribute the removal of the vast amount of rock which has disappeared from this area, to the action of the sea. But not so the present contour of the surface. I believe few doubt that that has been produced subaerially by some agency disintegrating the surface and carrying it downwards into the sea, thus scooping out the valleys and leaving the hills outstanding.

I need not recapitulate on this occasion the arguments which have been adduced by many to show that this work has been effected by rain and rivers, but I may be permitted, and indeed I conclude that, by the present task having been assigned to me by the local committee, I am expected to give a short account of my own views upon the subject.

In such a country as this, where many of the strata consist of mixtures of clay with large flints, and boulders of igneous and other hard rocks, I cannot conceive how rain can have cleared them away.[3] The difficulty is the same

[1] Geology of Norfolk, p. 26.

[2] GEOL. MAG., vol. IV., pp. 447, 453.

[3] See Mr. Mackintosh's letter GEOL. MAG., vol. IV., p. 571.

where the strata consist of coarse gravelly Drift, as for instance in the lower beds of the Middle Drift, which form the picturesque hills about Cromer. If the surface of the lower ground be examined, where the rich land occurs upon the upper portion of the Lower Drift, as it is seen in section in the cliffs, we find no great accumulation of any such material, as it seems to me must have been left behind, had the denudation of the superincumbent Middle Drift been due to its having been gradually washed away by rain or melting snow. This is a negative argument.

On the other hand, I have long had my attention directed to the condition of the surface in districts consisting of sand, gravel, and clay, and I think that I see unmistakable evidence of the soil having been moved in a plastic state to the depth usually of from three to five feet; furrows being often formed which run to a greater depth. These must not be confounded with sand pipes in calcareous strata, which are chiefly due to solution, but they occur over all kinds of strata alike. Often we see, in the manner in which the movement of the surface has taken place, evidences of pressure. The material which has been thus pushed onwards consists of a mixture of the subsoil with material derived from the higher grounds. Stones are suspended in clay, and not always collected at the bottom, as if the matter had been arranged by water (though sometimes that is the case). This is the material which I have called "trail."[1] It is not identical with the "warp," which is a somewhat similar, but more recent and superficial covering derived from the action of the weather upon the trail. The warp contains organic remains, but I believe the trail never does so.

I have suggested that this peculiar condition of the surface, as also certain other phenomena, such as the reversal of the edges of slaty laminæ,[2] as described by Mr. Mackintosh, may be due to land ice;[3] and I have shown that, on Mr. Croll's theory of climatal changes, it is probable that a condition of things, conducive to a glacial climate, probably existed in this country about 110,000 years ago.[4] But I am open to conviction from any one who will explain the phenomena on a different supposition.

The remote age which I have assigned to the trail on the Glacial theory may appear startling, at least to those more careful geologists who keep note of their drafts upon the bank of time. But I have shown that the trail is so old, that considerable geological changes have taken place since its formation. It is older than the *Scrobicularia* mud, which skirts our estuaries, and older than the submerged forests which lie beneath them,[5] in which *Elephas primigenius* occurs.

But putting aside the argument for absolute dates from climatal considerations, and reverting to the usual geological scale of relative antiquity, we have evidence from the manner in which the lower parts of valleys are occupied by forest grounds, covered with ancient mud containing estuarine shells, and those covered again by turbaries,[6] that the present configuration of the surface, with the exception of very minor subsequent modifications, dates back to a far distant and prehistoric age. For it is evident that the same configuration of hill and dale existed, and indeed must have been formed, when the land was higher than it is now, and when those portions of the valleys, which are now either drowned, or covered by marsh land, were considerably raised above the sea.

But carrying back our observations to a period long antecedent to the submarine forests, we find evidences of a similar cycle of events. We have a form of surface almost, but less nearly, identical with the present one, and an older drowning of the lower valleys. The former surface exhibited in the section of the old valley at Mundesley belongs to this period, and the marine deposits of the Valley of the Nar probably to its later phase. As far as I am at present aware, the period of elevation to which I am referring is characterised by the common occurrence of *Elephas antiquus* in company with *primigenius*, and also of *Rhinoceros leptorhinus*. *Unio*

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[1] Journ. Geol. Soc., vol. xxii. p. 553. In a small pit adjoining Mr. Barnes' brick pit at Surlingham, I saw a fine exhibition of the trail with stones from the Boulder-clay, one of which was about twenty-five pounds weight.

[2] Journ. Geol. Soc., vol. xxxiii., p. 323.

[3] GEOL. MAG., vol. III., p. 483.

[4] *Ibid.*, vol. IV., p. 193.

[5] Journ. Geol. Soc., vol. xxii., p. 553.

[6] The shells from Downham, near Ely, are *Scrobicularia Cardium*, &c., and there was a forest beneath, and the bones of beavers are found associated with it.

littoralis is also common, and *Corbicula fluminalis* in the lower parts of the valleys. Worked flints do not appear to be usual (if, indeed, they occur at all) in the deposits of this age. The occurrence of *Elephas antiquus* in association with worked flints appears by no means usual.[1]

The valley deposits of Ilford, Grays, Clacton, Lexden, and Walton-on-the-Naze, all in Essex, appear to be of this earlier age; and at Clacton there is clear evidence, and at Grays probable evidence, that a subsequent submergence occurred, since the lower part of the deposit, in which the mammalian bones and land and freshwater shells are found, is covered, in the one case by a distinctly estuarine deposit, and in the other by false bedded sands, which can scarcely be otherwise than estuarine.

I would refer the marine deposits of the valley of the Nar to the close of this period,[2] because they are newer than the Boulder-clay[3] but older than the estuarine mud (*Scrobicularia* clay) of the Fens,[4] which, as already mentioned, overlies the submarine forest. But it must be admitted that the exact age of the Nar deposits has not hitherto been determined.

I am disposed to place the deposit at Mundesley among the earlier valley deposits, on account of the occurrence of *Elephas antiquus* there. Mr. Gunn has the specimen in his possession, which was obtained from the dark silt (*b*) of Mr. Prestwich's section.[5]

The consideration of the present condition of the surface in connection with the form of the ground and of the denuding agents has led me to refer to the order of the later events in a reverse order. I will shortly recapitulate them in the order of their occurrence.

After marine denudation had removed vast quantities of deposits, probably exposing the Chalk and the other strata in those areas which they now occupy, the earliest valley denudation, of which we have records remaining, was that characterised by the *Elephas antiquus* in company with *primigenius*. This valley system was partly submerged, and again re-elevated to an altitude greater than the present. This second period was that of the *Elephas primigenius*, with but few of its former companion, *antiquus*, and of the fabricators of the early chipped implements. A subsequent denudation took place, of which the travelled material, which I call trail, is the testimony.

The warp covering the general surface was formed toward the latter part of this period, and, as I conceive, the Reindeer then lived in our latitudes, and *Elephas primigenius* still survived. This was the period also of the submarine forests which occupy most of our low shores. A depression then occurred which covered the lower forest grounds with the *Scrobicularia* mud (called "buttery clay" in the Fens), and I have found the warp of the lower grounds beneath it in Essex.[6]

A final elevation of a few feet introduced the recent period.

I have already alluded to the condition of the surface which shows traces of the upper portion having been moved in a plastic state. I will now call your attention to some features in the *contour of the surface* in this county which ought to throw light on the mode of final denudation.

In the first place the broads of Norfolk are a peculiar feature. They are portions of the valleys which have not had time to become filled up, either by silt or by the growth of peat. If the mode of filling up of the broads, as it is now going on, be observed, it will be found that the peat encroaches from the edges. Hence, as might be expected, we find the wider parts of the valleys to be those which are occupied by broads, for it is evident that these would take longer to be filled. But why should we find this feature in this part of England in particular? Is there any thing peculiar to Norfolk which may account for it? There is this. The winter isothermal of 32° F. takes a course parallel to the eastern coast of England, skirting the western extremity of Norway. Consequently we may well conceive that, under a severer climate, glacial conditions would have lingered longer in the eastern than in the western parts of England, and that the bottoms of valleys would have been still occupied by ice here, after they had become clear of it in the west. Hence the commencement of the process of filling up would have been delayed, and whereas it is completed elsewhere, it would be still in progress here.

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[1] "Antiquity of Man," pp. 134-173.

[2] For Mr. Rose's description of these deposits see Phil. Mag. vol. viii. p. 30, and GEOL. MAG. Vol. II. p. 8. For Mr. Trimmer's ditto, Journ. of Agricultural Society, vol. vii. p. 469, and Geol. Journ. vol. vii. p. 23.

[3] Rose, Phil. Mag., vol. viii. p. 34.

[4] *Ibid*. p. 36.

[5] Brit. Assoc. 1860. See Geologist, 1861, p. 69.

[6] Jour. Geol. Soc., vol. xxii. p. 562.

The windings of the valleys also appear to be on a larger scale than can be due to such rivers as the size of their gathering grounds could produce. This is especially noticeable in the valley of the Bure. Thus Belaugh church stands on an isthmus of high ground, and the valley takes a sweep round it three miles long, returning almost to the same point again. The actual river winds in small curves at the bottom of the great valley. Now Mr. Fergusson in a paper on the Ganges[1] tells us, that the magnitude of the curves, in which a river oscillates, increases with the width of the river, and though it is not easy to discover the exact relation, yet it is evident, if his views be correct, that such curves, as those of the Belaugh valley, could not have been made by the stream of the river Bure, even under conditions of much greater precipitation. But the erosion caused by the sweeping course of a wide and slowly moving stream of ice, seems to me capable of having formed them.

The valley of the Waveney and Little Ouse, which forms the southern boundary of the county, has some peculiar features of interest. I have already referred to facts which render it probable that there has been from very early post-cretaceous times, a submarine valley of erosion in this direction.[1] But it is evident from an inspection of the country, that the present valley was formed at the same time as others around it, although its position may have been determined by previous events.

The peculiarity of this valley is that it intersects the watershed at right angles, and slopes east and west to the German Ocean and the Wash. The watershed in the valley is formed by a very low ridge of sandy ground, not more than four or five feet high, and 235 yards across. East and west of this commence wide fens, which occupy the upper end of the eastern and western portions drained by the Waveney and Little Ouse respectively. The Ordnance map is deceptive in making it appear that these rivers rise together, and then separating, flow east and west. It is not so. The sandy tract just mentioned intervenes. But what is material to my purpose is that the valleys of these two rivers do not really commence at this watershed. The Waveney really rises in Norfolk to the north of this, and the Little Ouse in Suffolk to the south. The valleys then inosculate, and thus the appearance of one continuous valley reaching from sea to sea is produced.

If the excavation of this valley had been produced by river action, it is inconceivable how it could have been excavated over the watershed. For an eighth of a mile the bottom of the valley is almost flat, and there is no natural watercourse through it. If the two streams had done the work, they should have been separated by an elevated ridge, not by a flat area. If, on the other hand, two glacier streams had descended from the lateral valleys, they would have widened out where they made their bends to the east and west, and, mingling at their edges, might, I think, have ground down the surface to a nearly uniform level at the watershed. The shape into which the valleys are cut on the confines of the watershed, and the manner in which they narrow, subsequently favour, I believe, this view.

Another feature of the surface peculiar to this district is the occurrence of small sheets of water, usually called meres, on the higher parts of the county in the neighbourhood of the watershed. They are usually the sources of small streams. I examined one of these which has been lately drained. It is called Rockland Mere. It is a true basin about eight feet deep. It is now occupied by peat, and at the present season there is scarcely any moisture draining from it. It is excavated in Boulder-clay, and the country bordering on it sinks gradually to it, showing no feature whatever. I cannot conceive rain or rivers having excavated these meres, nor are they of marine origin, for there is no symptom of a sea bottom. The surface at Rockland, as shown in the drain, has the ordinary character of the Boulder-clay, with a covering of trail, and in one spot, about 200 yards below the outlet, this trail consists of clayey gravel, with large flints from the Boulder-clay, cutting

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[1] Journ. Geol. Soc., vol. xix., p. 323.

[1] P. 545.

into a clean white sand, which hereabouts is a member
appear, then, to be of the character of tarns, formed
Ramsay, true tarns have been) by ice, which in this ca
towards the spot occupied by the mere, where its accumul
erosion, and thence taking the direction of the present o
vation of the valley.

Such depressions in other districts have no doubt exis
up and masked by lacustrine deposits. In Norfolk the
longer, and the original hollows remain.

IV.—DIAMONDS FROM THE CAPE OF

By JAMES R. GREGORY.

WERE the diamonds said to be found at
England, really found in South Africa?
from the so-called diamond district, to whic
from England, being deputed by Mr. Harry
merchant, of Bond-street, who is well known
scientific enquirer on the subject of precious sto
felt a great desire to develop a new source of s
in which he is so largely interested. During th
Africa I made a very careful and lengthene
district where the diamonds were said to have
no indications whatever that would warra
the finding of diamonds, or of diamond-beari
the localities.

The geological character of that part of t
impossible, with the knowledge we at present
bearing rocks, that any could have been re
The whole of the district from Cradock, almo
Hopetown, upwards of 250 miles, is composed
rocks; the huge piles of rounded boulders are
the Trap dykes in many places that have fo
sands both of a white and red colour, a
from the breaking up and wearing away of t
and burnt clays, or Porcellanite, which w
through the volcanic heat vitrifying these silic
geological deposits are visible, nothing but
rocks, and the sands mainly produced by the
associated with these sands and in the bed
Vaal Rivers are the characteristic Trap mi
Zeolites, Natrolite, and sometimes Stilbite, w
geodes of chalcedony, from the interior of whic
dimensions, are derived the brilliant rock cryst
may be found, most of them rounded on the e
perfectly uninjured, as the usual hexagonal p
both terminal pyramids.

As further proof of the great antiquity of
in a river bed about thirty yards in width, a
River, near the junction of the Orange and V
some very large boulders of Trap, some three

containing imbedded in them *smaller boulders* of similar Traps, but of various colours, and these contained the zeolite mineral, chalcedony, green earth, etc., which had evidently been rolled and water-worn to a rounded form, before being enveloped in the newer Trap, when in a fluid or pasty condition.

Frequently associated with, and on the top of these beds of sand and *débris*, are beds of a compact calcareous tufa, which in many places is broken up and forms a mingled mass of a gravelly-like compound of lime, small agates, quartz crystals, yellowish chalcedony, some of which is burnt red (carnelian) by exposure to the sun; also fragments of natrolite and green earth from the Trap, together with small pebbles of different-coloured Trap. Sometimes this loose gravelly mixture is by the aid of the lime present formed into a solid conglomerate,—not siliceous conglomerates, as those from Brazil. This is an important distinction, it having been quoted as resembling that from Brazil. A traveller who has recently passed through this district described this calcareous tufa as *primitive* limestone. This was in the neighbourhood of Campbell.

In these so-called diamond-districts there are no traces of what are usually termed metamorphic rocks, such as mica-slate; no granite or gneiss, nor any traces of the minerals usually, nay always, found in diamond-districts. as Zircons, Anatase, Rutile, Brookite, Cassiterite, Iserine (Titaniferous Iron), Gold, Platinum, Topaz, etc., such associations in fact as we find in Brazil, India, Australia, etc.

Now, again, if we consider the almost solitary instances in which diamonds are said to have been found, and at comparatively long intervals of time, not more than fifteen or sixteen individual diamonds in two years or nearly,—and extending over only a limited district not more than thirty miles long by fifteen miles in breadth, —it seems perfectly conclusive to me that the whole story of the Cape diamond discovery is false, and is simply one of many schemes for trying to promote the employ and expenditure of capital in searching for this precious substance in the colony. I had an idea of this when I first reached George Town, then at Port Elizabeth, Grahamstown, Cradock, Colesberg, and finally on arriving at Hopetown, when no further proof of diamonds could be obtained. At all these places I carefully looked over bags of stones, which were said to be from the diamond-district; nothing else but Agates, Chalcedony. rounded Rock-crystals, and rounded Natrolite—no other minerals whatever. The diamonds were said to have come from a distance; so they have doubtless, but many thousand miles of the present ocean separates the localities. I have little doubt but that the first idea as to the finding of diamonds here was the picking up of the small brilliant rock crystals, and the idea that they might be diamonds by persons unacquainted with them; and this is assisted by the local newspaper editors, who publish any communication whatever that is sent to them. Persons read some work on diamonds and then fancy that they understand all about them, and insert in the papers paragraphs which are totally at variance with the real facts as to the character of the rocks or sands. Now a knowledge

of geology and mineralogy is only acquired by
tinued experience, and not to be learned in a
to a book ; and estimating the commercial va
in the uncut state as well as polished, is, ag
experience.

In reference to the valuing of the diamon
found at the Cape, I will now say a few wo
exist the same inexperience by persons who ha
describing the districts where they were found
a diamond, really worth £10 or £12, which
£60 or £70, and in the same proportion for la
Cape people say that if a diamond fetches £70,
this is not so, the buyers being equally ignor
the sellers. On Friday, July 10, a diamond w
town, which was said to have been found by
found the one called the Puiel diamond, or No.
more presently. It was shown to me by the
Hopetown, who asked me the probable weigh
merely guessed the weight at from 12 to 13 car
found to be 12⅝ carats : the quality was so in
size mentioned, that I could only value it at £
considering the quality, which was really li
termed "loart," was a high valuation. I afte
return from Griqualand, that some one at Ho
it as "of the *first water,* one part very much
value £50.

When I was at Port Elizabeth, I happened t
had just arrived at Grahamstown on its way
started off the next day to try and get a sight
late, it having been sent away the day before
photograph and plaster of Paris cast of it, thou
made out from those, as a diamond of 15 carats
a photograph or plaster cast, for minute and ca
plaster cast of this stone is now in the Museum
Now, from the appearance of the surface of thi
which seems to be carefully taken, there a
racteristics of a rough diamond, which appears
fine transparent stone, as far as I can judge f
racters. Yet, in the Cape papers, this stone
and weighs 15½ carats, and of the *first water,*
any defects. This stone was stated to have
Griqua on the banks of the Vaal river, near Pui
this was not true, and it was said to be really
100 miles from Puiel, and by a Griqua who
or three others. So the locality at Puiel is a m
I had from the farmer in whose employ this
said to have found it. The diamond was value
wards at £1000, £800, £600, and finally at
valuers were certainly a long time in making
the true value of a solitary diamond, when a

would have estimated it to within five or ten pounds in five minutes. [For these various valuations consult any file of Cape papers for May, June, and July, 1868.]

It is said at Hopetown that a native has a very large diamond, but will not part with it, nor show it to any one, nor has any one, I believe, seen it; and, therefore, I suspect it to be a myth, as a Griqua would only be too glad to convert it into money or cattle, etc. Here is another fact which certainly does not prove much for the diamond discovery:—A person had a farm in the neighbourhood of Hopetown, which he wanted to exchange for reasons best known to himself. He got a resident in Hopetown, who is one of the authorities on the diamond question, to give him a certificate that he had found two diamonds, knowing at the same time it was false. This diamond valuer gave him the required certificate *without seeing the diamonds*, through the help of which he exchanged his farm with the government—he afterwards confessing that he had not found two diamonds on the farm, but merely wished to exchange for a better locality. I can now only conclude by expressing my conviction that the whole diamond discovery in S. Africa is an imposture—a Bubble scheme.

V.—On the Gold-fields (?) of South Africa.

By James R. Gregory.

GOLD is said to have been found in South Africa, and very probably it is. I have myself an undoubted specimen from the copper mines in Namaqualand, in which the gold is imbedded and associated with silicate of copper or chrysocolla; but with regard to the "diggings," as they are called by the Cape papers, and which are situated some considerable distance up beyond the Great Orange River, and north and west of Natal, the question is whether the gold is in sufficient quantity to pay for the labour and expense of its production. It is certainly very premature to call this auriferous district "Gold diggings" and "Gold fields," when really not ten ounces of gold have as yet been produced altogether in something like twelve months. Parties have been up and returned, each on some very trivial excuse. Some travellers describe the gold quartz as containing gold in large quantities, and yet they have not obtained satisfactory specimens themselves, although these "*rich beds* (it is said) extended over many miles of country, and rich gold quartz could be had almost for the trouble of picking it up." The great idea seems to be in getting persons to come out on a wild-goose-chase, when nothing definite is known about these wonderful "diggings." Ancient furnaces are said to be found in the neighbourhood, and of course plenty of fuel !!

I have just returned from South Africa, though I confess that I have not been to the so-called gold-diggings. I simply read the reports and communications in the Cape newspapers, and having mixed with many people acquainted with the district, I have formed an opinion of the probability or plausibility of the reports, and reasonable expectations of the success of the seekers of gold in this part of the world.

I will mention a few facts that came under my own observation. For instance, while I was at Hopetown, a trader came in from the so-called Bamangwato diggings. This is the most southerly of the gold districts. He showed me and put in my hands one evening a piece of quartz on which gold-leaf was fastened. I immediately detected the imposture, and exposed it at the time, several persons being in the room. Yet, in the next issue of the *Colesburg Advertiser* for July 14, 1868, was the following paragraph:—"We (*Colesburg Advertiser*) have received the following, under date Hopetown, July 9:—'Lishinskey has arrived from the Bamangwato, and brought down some specimens. Mr. Gregory, the mineralogist, who is here from England, pronounces them very rich. At the place where they are now searching for gold there are old diggings, as they have found furnaces which appear to have been built hundreds of years ago,'" etc., etc. And again: "Capt." Black and his party have obtained about two to three ounces of gold dust as fine as snuff, and have been digging two to three months, and expect to get *nuggets* as they go deeper! (there are six or seven persons in this party). Now we see by a mail that came home about three weeks ago that Capt. Black and his party had returned from the diggings, *not because there was no gold*, but that they could not agree among themselves. Is this a reasonable and satisfactory excuse? And by the last mail which arrived here on the 6th of November we learn that the Cape Government have not yet organised a commission to enquire into and examine the auriferous districts, but that private commissions have been organised, and have started to the gold districts. Does this look altogether satisfactory as to the private opinion of the Cape Government? Another fact: When I was on my journey home in the steamer from the Cape, a passenger from Natal, in presence of myself and several others, said that he considered it perfectly fair and legitimate to represent that pieces of gold quartz, from Australia or elsewhere, were found in the South African gold-fields. This will give a further idea of the commercial morality of these colonies, and show that they are not behind other countries in bubble schemes.

I merely wish to call the attention of persons about to visit or embark in the gold-digging speculation, to carefully read and digest the various reports from the gold-diggings before venturing too much on the faith of newspaper paragraphs. And one thing especially, don't believe any specimens you see of gold quartz that are said to have been found in South Africa, without knowing personally the finder and receiving them direct from him. Many persons have quartz said to be from there; but none have had it direct, and generally it has passed through several hands. Finally, look in the money article of the *Times* of any date, and compare as a fact the so many thousand ounces of gold now on the way home from Australia, &c., with the very unsatisfactory accounts from the Cape.

What I complain of is that these gold-fields are too much puffed and advertised, before anything whatever is known of their capabilities for working and realisation. It may turn out eventually as a good place for investment of capital, and I hope may. But this puffing is altogether much too premature. The commencement of Australia and California was very different. The actual nuggets turned up honestly, and spoke for themselves.

NOTICES OF MEMOIRS.

I.—On a Remarkable Incrustation in Northamptonshire.

By Samuel Sharp, F.S.A., F.G.S.[1]

A SPECIMEN of a plant incrusted by carbonate of lime having been left at the Northampton Museum (of the Geological Department of which I am the Hon. Curator), I visited the place whence it had been brought—an ancient gravel-pit about three miles from the village of Old or Wold, and some fourteen miles N.N.E. of Northampton.

The section exposed is about eight feet in height, and the gravel contains broken flints, angular and sub-angular fragments from the Oolitic limestone and ironstone of the district, and rounded pebbles, composed for the most part of materials foreign to the locality, and derived from older gravels or from the Boulder-clay which caps many of the high lands in the county.

In the section of the gravel, I found the mass of incrusted plants from which the small fragment had been taken. This, as seen in the section, is about ten feet in length, and about two feet six inches in thickness (see Woodcut). Its dimensions inwards were not ascertainable, and no trace of it was to be found in the opposite section of the pit, distant some fifteen or twenty feet. It reposes upon six inches of calcareous paste, made up of the decomposed material of the mass, and this paste again rests upon the gravel as a base.

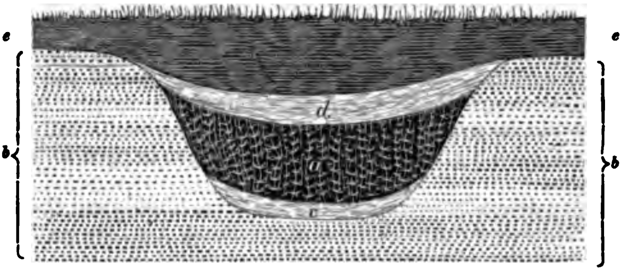

Diagram-section of side of Gravel-pit near Old, Northamptonshire, showing position of ancient tufaceous deposit containing *Chara vulgaris*.

- *a.* Mass of incrusted *Chara vulgaris* (2½ feet in thickness, and 10 feet in breadth.)
- *b.* Stratified gravel (8 feet in thickness).
- *c.* Lower layer of calcareous paste (6 inches in thickness).
- *d.* Upper layer of calcareous paste (12 inches in thickness).
- *e.* Surface soil (9 inches, deepening to 1 foot 9 inches).

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[1] Read *before the* British Association, Section C. Norwich, August, 1868.

A similar layer of calcareous paste, one foot
the mass, and has partially filled the interst
plant. The whole is covered in with surface
of one foot nine inches, the depth of the gene
lying the gravel being only nine inches, but th
the same.

The gravel is stratified, showing that it has
since it was originally deposited, and the strata
of incrustation on either side, abutting sharpl
evidently once continuous.

These are the simple facts which I ascertain
of the mass of incrustation *in situ*, and upon ob
rounding circumstances; and I may, perhaps, be
briefly what may have been the history of its fo

Ages before the ground was first broken t
gravel pit—at a period perhaps as remote as t
roamed over the country, an excavation was ma
bably to obtain water) and a pool was formed,
and about five feet deep, in which grew luxur
which Mr. Carruthers, F.L.S., F.G.S., of the
kindly informed me was the *Chara vulgaris* of L

Rain, upon falling on the surface, soaks throu
colating the porous rock beneath, descends by
stopped by the occurrence of a clay or other im
accumulates and travels until it finds vent at fav
surface, and issues thence in the form of spring

It is not an uncommon thing for water, c
acid, to dissolve out and hold in solution a ce
from any limestone which it may encounter
flow; but, upon becoming exposed to the atm
acid would fly off in the form of gas, and the
hold the lime in solution being thus impaired,
of lime would be precipitated, and collect roun
any nucleus, even a growing plant, which migh
water.

Withering describes two species of *Chara* (*C. h*
—which become covered with a stony crust,
"they possess the property of absorbing carbon
lime has been held in solution, in a greater d
water-plant;" and this would enhance the ten
which such plants might grow to deposit lime,
incrustation of those plants.

The gravel contains many fragments of the lim
and I found in it pieces which apparently had
dissolving agency described.

The *Chara*, then in its rich and matted growt
thus impregnated with lime, became incrusted
and gradually upwards—as the plant, still accum
approached nearer and nearer to the surface.

By this slow process of growth and incrusta course of time, was choked up, becoming at length only a shallow puddle. The six inches of calcareous paste at the bottom was probably produced by the crushing of the lower portion of the incrustation by the superincumbent weight; and the thick layer at top, partly by atmospheric disintegration, and partly, perhaps, by the trampling of cattle while drinking. The pool ultimately became a mere marshy hollow, and was then artificially filled in with soil to the level of the surrounding surface. The gravel-pit was subsequently opened, and what had been the hollow of the pool was thus thoroughly drained.

The incrustation lies in layers, the plant stems being in a greatly inclined position. I would suggest that this may, perhaps, be attributable to the deciduousness of the plant, or to the variation in the water-level arising from the change of seasons.

There is one peculiarity which I must notice. The gravel-pit is situated on the slope of a rather shallow valley, through which flows the brook I have referred to. The bottom of the pit is some feet above the level of the water of that brook, and about three feet below the bottom of the supposed former pool: at a time of the year when water should have been present, if at all, the pit was perfectly dry. It is clear, then, that the old local conditions must have been very different to the present, to have rendered it possible for water to accumulate in an excavation in that open gravel to such an extent as to allow of the *Chara* growing in luxuriance to within a foot of the surface. It would really seem that, in the long interval which has elapsed since the growth and incrustation of that mass of plant, a change must have taken place in the level of the locality, and that the valley itself must have been excavated to a greater depth. If this view be sound, and the pool or hollow be really the work of man's hands, we have here another item of evidence of the high antiquity of the human race.[1]

There is yet another consideration. Had the gravel pit not been opened, the calcareous paste of the upper bed would, by percolation, in the course of time, have completely filled up the interstices of the mass of incrusted plant, and ultimately the whole might have become hardened into a marly limestone rock. If excavation should then have occurred, what would have been the reasonable conclusion as to the nature and origin of the apparently calcareous mass? Would it not have been that, occurring in the stratified gravel, it was a transported block, and its presence in such a position attributable to Glacial agency?[2]

[1] Mr. George Maw, F.G.S., etc., upon the facts as detailed by the writer of the paper, has expressed an opinion (qualified by the consideration that he has not examined the place) that the hollow was the work of human agency.

[2] The valley is cut through the lower beds of the ferruginous sandstone of the district; upon the slope so formed the gravel was deposited, and the ferruginous sandstone reposes upon the upper Lias clay. Neither of these beds contain sufficient calcareous matter to allow of any subsidence arising from the dissolving out and carrying away (by the action of water charged with carbonic acid in solution), of any considerable portion of their mass.

II.—On the Tertiary Deposits o

By H. M. Jenkins, F.G.S.[1]

THE geology of Victoria is better known th
British colony, the existence of gold-bearin
localities having led to the establishment of a G
Survey about twelve years ago. The labours
the able direction of Mr. Selwyn, have made
general way, the geological structure of the
more detailed survey is now in active progress.

The marked contrast to our knowledge of th
of Victoria is our comparative ignorance of its p

Under these circumstances Mr. Selwyn has
determination a large series of Tertiary fossils
he has mapped as Miocene and older Pliocene ;
some points of very great interest to the pal
an account of the localities whence they had
preface to a report on the fossils, which he ho
Association on a future occasion.

One point of great importance, depending on
tation of the age of these Tertiary strata, is the
gold-drifts of Victoria. Their age relatively t
been tolerably well made out by Mr. Selwyn
scientific interest, their antiquity in relation to cl
and in the fauna and flora of the region, has sti

The most varied section of the marine Tertia
exhibited on the coast west of Cape Otway,
southwest of Port Philip Bay, where the Te
accumulated in a trough of Mesozoic carbon
tween Castle Cove and Cape Otway ; and the
afterwards contorted and then denuded ; an
deeper and probably narrower, was refilled wi
false-bedded sandstone.

It is of great importance to determine the re
as one of them has yielded the *Trigonia semiund*
of Secondary type, quite different from the rece
comparable with the *T. costata* of the Oolites.

About twenty miles west of Castle Cove, a
beyond Moonlight Head, another series of Ter
resting, as before, on the Mesozoic sandstone.

West of the Gellibrand river the Miocene be
Post-pliocene calcareous sandstone, dipping to t
in the opposite direction to those on the other
mouth. They extend along the coast for nea
their stratification and divisions are much ob
masses of the more recent Tertiary sandstone.
bed is a dark, slate-coloured, stiff clay, very

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[1] Read before the British Association (Section C.) Norw

remarkable for yielding, perhaps, the finext examples of *Cypræa* which occur in the fossil state. The fossils from this bed present a very striking contrast to those from the eastern side of the River Gellibrand in the perfection of their preservation.

The author then described some small sections still further west, and afterwards the strata on the western side of Port Philip Bay, at Fyansford, about four miles west of Geelong, whence fossils have been obtained from a section exposed in the cliff on the right bank of the river Barwon.

A little west of Geelong, and close to the shore, the cliffs exhibit Miocene strata, which have been correlated by the geological surveyors with the upper part of the Spring Creek series, further to the south, where a very extensive succession of beds has been made out, extending from the mouth of Spring Creek to the Bird Rock, and presenting a total thickness of about 280 feet.

On the eastern shore of Port Philip Bay the series is even more diversified. It is also of peculiar interest, as Professor M'Coy regards certain of the strata on this side, near Mount Eliza, at Schnapper Point, as belonging to the upper Eocene period; but it is extremely difficult to decide what characters would entitle an Australian deposit to be regarded as Eocene. Nummulites have not yet come under the author's observation, and the shells appear to have too recent a facies for an Eocene fauna, although some of the volutes do recall the species of our Bracklesham beds, and those of the German Oligocene deposits.

Mordialloc, about fifteen miles north of Schnapper Point, is of interest on account of a boring for an Artesian well having been sunk there to a depth of 240 feet, the basalt which underlies the strata of that district having been struck at a depth of 235 feet. From the sandstone cliff north of Mordialloc, fossils have been obtained which, though badly preserved, are evidently of more recent date than those from the beds near Mount Eliza; indeed they are mapped as Lower Pliocene by the Geological Survey of Victoria. The beds exposed do not exceed 18 feet in thickness.

The fossils from these various deposits yield nothing either in numbers or in beauty of preservation to those of the London or Paris basins; but until they have been carefully worked out, and their affinities properly determined, it is extremely hazardous to venture on any opinion as to the age of the strata from which they have been obtained. That there are several horizons is at once evident, and that some of the assemblages of fossils from different localities are contemporaneous is extremely probable. For instance, the deposit near the Sherbrook river, which has yielded the *Trigonia* of recent type (*T. Lamarckii*), is probably referable to the same horizon as the Mordialloc deposits, which are characterised by the same form of *Trigonia*, and which have been mapped by the geological surveyors as Lower Pliocene.

III.—ON THE FOSSIL FISHES OF THE DUCHY OF CORNWALL.[1]

BY C. W. PEACH, A.L.S.

IN 1841, at the meeting at Plymouth, I read a paper on the above subject, and stated that I had found "portions of fishes at Punch's Cross Quarry near Fowey." Again at Cork in 1843, I continued the subject, having met with far better specimens, and still finer had been found by Mr. Couch, at Polperro; these latter with some of my own were there exhibited and commented on by me.—From that time to 1849, I continued to extend my researches, and met with fish-remains on both sides of the county. All these, I felt satisfied, were portions of fishes, and in this opinion I was supported by several eminent naturalists, especially by the late valued Professor E. Forbes, Mr. Pengelly, and others. In 1849 I left Cornwall for Scotland, and have not again been there.

These things were considered fishes until 1855, when Professor M'Coy (who had been some time before round Cornwall with Professor Sedgwick) stated in the "British Palæozoic Fossils," published at Cambridge, after carefully examining some of the original specimens, and others that he had collected, that they were *not Fishes*, but *Sponges*, of which he made out two species. So they have been considered up to April of the present year, when Mr. E. Wyatt-Edgell, in the GEOLOGICAL MAGAZINE, for May, said, that the so-called *Steganodictyum* (Sponges) of M'Coy were true Fish-remains; and in this he is supported by Professor Huxley, Messrs. E. Ray Lankester, Salter, and Woodward. I confess to feeling pleased at knowing, that, although these interesting remains have been so long under a cloud, light has at last broken upon them, and that their true history will soon be told. Although I have bowed silently to authority so long, my opinion as to their fish character has never changed; and in all my wanderings over the Old Red Sandstone of Caithness, and other parts of Scotland,—with one exception, to be mentioned bye and bye,—the only thing in all the fishes I met with, and these may be told by hundreds, I never found one which agreed with the Cornish ones; however, a few decayed bones of *Osteolepis*, etc., showed the same cancellated structure as the specimens from the Cornish rocks. In May last I went on a visit to my son, who is in the Geological Survey, at Lesmahagow, and amongst the Blackband Ironstone, in one of the coalpits at Auchenheath, I got fish-remains showing identically the same net-work cancellated structure. This peculiar structure deceived morethan Professor M'Coy. Many named it to me when talking about the Cornish fishes, because "it differed so widely from that of any known animal structure:" consequently they refused to believe them fishes. Here let me do justice to Professor M'Coy. He did not see the specimens on which I formed my opinion: they were with me in Scotland, and were not sent to the Geological Museum at Penzance until long after he had given his decision. The exception above mentioned is a small tuberculated piece, one of those sent to the Cornish Museum, and figured by me in the Geological Transactions of Cornwall, for 1848, at Pl. iii. Fig. 2: it is so much like the outer part of an *Asterolepis*, or *Coccosteus*, that the late Hugh Miller, on seeing it, said, "had he found it in Caithness or Cromarty, he should without hesitation have considered it as belonging to one of those fishes." Strong testimony this. I have lately seen the paper of Mr. E. Ray Lankester, in Vol. xxi. of the Palæontological Society, and by the figures and descriptions there given, I am the more convinced of the Piscine nature of the Cornish fossils, and farther, that they will prove to belong to some of the families described there. The Cornish ones are *very much larger*, and consequently may prove new species. Roused by the new state of affairs, I have turned out the contents of a box, packed twenty years ago on leaving Cornwall, and up to that time untouched. Here I found a splendid cephalic shield. It is a little more than six inches in length, unfortunately not perfect. I have as well some nice but fragmentary specimens of scales and spines, all beautifully marked—these are merely a few odds and ends left after my collection was placed in the Geological Museum at Penzance. If these specimens were examined carefully, they would be found to throw a great deal of light on the subject, especially the spines. I greatly regret that I cannot go there to do it myself.

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[1] Read before the British Association (Section C.) Norwich, August, 1868.

REVIEWS.

I.—PRINCIPLES OF GEOLOGY; OR, THE MODERN CHANGES OF THE EARTH AND ITS INHABITANTS CONSIDERED AS ILLUSTRATIVE OF GEOLOGY. By Sir CHARLES LYELL, Bart., M.A., F.R.S. 10th and entirely revised edition. In two volumes. Vol. II. Illustrated with Maps, Plates, and Woodcuts. 8vo. pp. 649. London: John Murray. 1868.

IN the GEOLOGICAL MAGAZINE for 1867, Vol. IV. p. 120, we gave a brief notice of the new edition of the first volume of this grand work.

Great and important as had been the alterations in Volume I., we cannot but think that the second volume is by far the most valuable, both as to its matter and the treatment it has received from the author.

The following account of some of the principal additions to this volume will enable the reader to see how much labour has been bestowed upon the new edition. Much new information has been added to the chapter on Mount Etna, in consequence of the author's re-examination of this volcano in 1857 and 1858. The theory of a double axis of eruption is explained (p. 9), and the changes in the scenery of the Val del Bove, caused by the lavas of 1852, are described (p. 31). The solid texture and steep original inclination of certain lavas of known date are also pointed out (pp. 35 and 36), and the relation of some ancient valleys on Etna to the former structure of the mountain is considered (p. 40).

An account is given (at p. 69) of the changes produced by the recent eruption in the Gulf of Santorin in February, 1866; as also of the earthquake in New Zealand in 1855, and the permanent upheaval and subsidence of land in that archipelago, is given on the authority of Messrs. Roberts, Walter Mantell, and F. A. Weld. A new fault or shift of 9 feet in the rock is described, and a map of the region convulsed by the earthquake is appended.

In reference to the earthquakes in Calabria in 1783 and 1857, the origin and mode of the propagation of earthquake waves, is treated of and illustrated by several new diagrams (p. 135 to 140). Some account is also given of Mr. Robert Mallet's proposed method of calculating mathematically the depth of the earth's crust from which the shocks may proceed.

At p. 192, we have the observations of Messrs. Gwyn, Jeffreys, and Torell on Shells of the Glacial Period in the Uddevalla district in Sweden.

In chapters 32 and 33, the old notion, that the crystalline rocks, whether stratified or unstratified, such as granite and gneiss, were produced in the lower part of the earth's crust at the expense of a central nucleus cooling from a state of fusion, is shown to be untenable, since granite is found to be of all ages, and the metamorphic rocks to be altered sedimentary deposits, implying the denudation of a previously solidified crust. Also, that the latest chemical observations on the products of recent eruptions favour the doctrine, that large bodies of salt water gain access, during an eruption, to the volcanic foci. And lastly, that the reservoirs of melted matter in the interior, though vast, may hold only a very subordinate place in the earth's crust.

The heat supposed to be continually lost by the planet by radiation into space, may perhaps, it is suggested, be restored by solar magnetism in connection with electricity and chemical action.

In the 35th chapter, the objections originally urged against Lamarck's theory of transmutation and his replies are considered. Also the question whether, if new species are created from time to time, their first appearance would have been witnessed by the naturalist. Remarks are offered on the "Vestiges of Creation," and on the theory of "Natural Selection," as advocated by Dr. Darwin and Mr. A. Wallace. The change of opinion produced by Dr. Darwin's work on "The Origin of Species," is pointed out, and Dr. Hooker's views on the formation of species in the vegetable world by variation and selection are noticed.

The 36th chapter contains an explanation of Mr. Darwin's views on the formation of new races by selection, both unconscious and methodical, whether of plants or animals under domestication. His doctrine of "Pangenesis," or the manner in which long lost characters may be revived in the offspring of cross-breeds, is also alluded to. Likewise the fact that certain parts of animals or plants may be made to vary by selection, while other parts of the same remain unaltered. The hybridisation of plants and animals is also considered in its bearing on the nature and origin of species.

The 37th chapter treats of natural as compared to artificial selection. The tendency of species to multiply beyond the means of subsistence, the struggle for life, and the conditions on which "the survival of the fittest" depends, are explained. The opinions of Linnæus, De Candolle, and Darwin on species, are compared, and it is shown that alternate generation will not explain the mode of the origin of new species.

Chapter 38 is devoted to the consideration of the geographical distribution of species. The six great provinces of distinct species of terrestrial mammalia are chiefly dwelt upon, and the agreement of the limitation of the species of birds and reptiles, and even of the invertebrate animals generally, to the same regions is pointed out.

In chapter 39 is given an account of the migration and diffusion of terrestrial animals, slightly added to and corrected, from the ninth edition.

In the 40th chapter, on the geographical distribution and migration of fish, testacea, insects and plants, several additions and alterations have been made, *e.g.*:—On the species of marine shells and fishes on opposite sides of the Isthmus of Panama; Moths seen flying 300 miles from land; Sir C. Bunbury on plants of the Table-land of Brazil; Darwin on seeds and fruits immersed in salt water without injury; Robert Brown on the source of the gulf-weed, or *Sargassum*: Darwin on seeds transported by birds.

The 41st chapter is a new essay, and treats of insular floras and faunas, considered with reference to the origin of species. The islands of the Eastern Atlantic, especially the Madeiras and Canaries, their volcanic origin and Miocene age, are first treated of and then the extent to which the species of mammalia, birds, insects, land-shells, and plants, agree or do not agree with continental species. The identity, or non-identity, also, of species of all these classes found in different archipelagos, or in different islands of the same archipelago, is shown to bear an unmistakable relation to the facilities enjoyed by each class of crossing the ocean. The bearing of this relationship on the theory of the origin of species, by variation and natural selection, is pointed out.

The 42nd chapter treats of the extinction of species, among the additions to which may be mentioned the following:—Dr. Hooker, on extermination of plants in St. Helena, and Mr. Travers on the spread of foreign plants in New Zealand.

The whole of the 43rd chapter, on man, considered with reference to his origin and geographical distribution, is new, save the first five pages.

The antiquity of the more marked human races, and the coincidences of their geographical range with that of the chief zoological provinces, is considered. The question as to the multiple origin of man is discussed. The bearing of the theory of progressive development and of Darwin's theory of natural selection on the derivation of man from the inferior animals is treated of. Some remarks on submarine forests at Bournemouth, on the south coast of Hampshire, and the Bay of Fundy, are added.

A brief sketch is given, in retrospective chronological order, of the remains of man and his works which belong to the ages of Bronze and Stone. Implements of the Neolithic Period—of the antecedent Reindeer Period—and lastly, of the Palæolithic Period, are mentioned. The position of flint tools of Palæolithic age in the drift of the southern coast of Hampshire and the Isle of Wight, is explained.

At p. 564, the age of the pottery in the upraised marine strata near Cagliari, on the south coast of Sardinia, is discussed.

The 49th chapter is reprinted from corresponding or concluding chapter of the ninth edition, with some corrections in the nomenclature of corals supplied by Dr. Duncan, and some observations at p. 580 on the depths at which different genera grew. Allusion is also made, p. 609, to the large quantity of limestone in the oldest or Laurentian series of rocks in Canada.

Referring to the marked change which has taken place in the opinions of Sir Charles Lyell and other eminent geologists, on the subject of the Origin of Species by Natural Selection, Dr. Hooker observes, in his inaugural address, as President, at the opening meeting of the British Association for the Advancement of Science (Norwich, August 19th, 1868):—"On the score of Geology, the objectors rely chiefly on the assumed perfection of the geological record; and since almost all who believe in its imperfection, and many of the other school, accept the theories both of evolution and natural selection, wholly or in part, there is no doubt but Mr. Darwin claims the great majority of geologists. Of these, one is in himself a host, the veteran Sir Charles Lyell, who, after having devoted whole chapters of the first editions of his 'Principles' to establishing the doctrine of special creations, abandons it in the tenth; and this, too, on the showing of a pupil, for in the dedication of his earliest work, 'The Naturalist's Voyage,' to Sir C. Lyell, Mr. Darwin states that the chief part of whatever merit himself or his works possess, has been derived from studying the 'Principles of Geology.' I know no brighter example of heroism of its kind, than this, of an author thus abandoning, late in life, a theory which he had for forty years regarded as the very foundation of a work that had given him the highest position attainable amongst scientific writers. Well may he be proud of a superstructure, raised on the foundations of an insecure doctrine, when he finds that he can underpin it, and substitute a new foundation: and after all is finished survey his edifice, not only more secure, but more harmonious in its proportions, than it was before; for assuredly the biological chapters of the tenth edition of the 'Principles' are more in harmony with the doctrine of slow changes in the history of our planet, than were their counterparts in the former editions."

II.—Essai de Géologie et de Paléontologie Aveyronnaises, par P. Reynès. Paris, 1868.

THIS deferred publication of M. Reynès is of some geological interest. Originally intended (1864) for the journal of a Scientific Society, it is now printed separately, and is a valuable addition to the many memoirs previously published on the Aveyron district, by M. de Serres (1844), Parran (1856), M. Boisse, and others. The geological structure of the district consists of Igneous and Metamorphic rocks (porphyry, basalt, granite, and micha schist), which occupy about two-thirds of the department. the sedimentary rocks being only of limited extent. These latter comprise the Upper Silurian, Coal-measures, Permian, Trias (with its three divisions), Lias, and the Lower and Middle Jurassic strata, the drift or diluvial deposits occupying the valleys. The Devonian and Carboniferous limestone are wanting, and the Permian, Trias, and infra Lias are unconformable to the Silurian rocks, while in the north-east of the department the Upper Lias and Inferior Oolite repose transgressively on the Mica schist. The Trias is well represented (112 metres), but fossils are rare, gypsum occurs in the upper beds, but no rock-salt, and the springs which arise from these beds are not even saline. The *Avicula contorta* zone, although occurring in the departments of the Var and Hérault, has not been strictly recognised at St. Affrique (Aveyron), although some equivalent strata may exist there. The Lias is marked by the characteristic zones and many fossils, and the inferior Oolite, with its typical fossils, is overlain by brackish water, or estuarine strata (Zone à Cyclades), containing *Melania, Paludina, Cyclas, Mytilus, Unio,* associated with carbonaceous shales, imperfect coal, and Oolitic iron ores, or limonite; these strata have been described by Marcel de Serres (Bull. de la Soc. Géol. de France, vol. xvi., p. 99), and appear to represent the Moorland Coal series of the Oolitic strata of Yorkshire; they are covered by beds of the Oxfordian series.

Six plates of fossils and one of sections are appended to this memoir, as well as the description of the new species, some of which we are rather inclined to consider require further comparison.

III.—REVUE DE GÉOLOGIE POUR LES ANNÉES 1865 ET 1866, PAR M. DELESSE ET M. DE LAPPARENT. Paris, 1868.

THE fifth volume of this annual is of equal importance, usefulness, and interest to those of previous years, and contains a *resumé* of the more important geological works published during 1865, arranged under four heads, Preliminary, Rocks, Formations, and Geological descriptions.

IV.—CATALOGUES DES POISSONS DES FORMATIONS SECONDAIRES DU BOULONNAIS, par M. ÉMILE SAUVAGE. Boulogne, 1867.

THE Museum of Boulogne contains a fine collection of fossil fishes, chiefly from the Jurassic strata of the *Boulonnais,* as well as some from the Devonian and others from the Cretaceous rocks of the district, of which the above work is a catalogue, containing also description and four plates illustrating some of the species. From this catalogue, it appears that the ichthyic fauna of the *Bathonien* or Great Oolite consists mostly of Pycnodonts and Cestracionts *in about equal numbers,* and two Lepidoids, one of which, the Lepi-

dotus lævis, Ag. ranges from the Gt. Oolite to the Wealden beds, in fact, the species of the genus *Lepidotus* are more numerous, and have a wider geological range in the Upper Oolites than any other genera noticed. The *Oxfordien* and *Callovien* are very poor in fish remains, but the latter contains a new genus *Curtodus*, allied to *Strophodus*, but differing in the more gibbous and inflected form of the teeth.

In the *Kimmeridgien* and *Portlandien* beds the fish remains are fragmentary, such as teeth and scales, and rolled, as if accumulated on a coast line; no entire specimens having been found. The *Ganoids* are represented by *Lepidotus*, and the *Placoids* by *Strophodus*, *Hybodus*, and a new genus *Auluxanthus*, founded on an *Ichthyodorulite* from Portel, which is flat and finely striated, the anterior margin blunt, the posterior with a shallow furrow throughout its length, the borders of which are furnished with small points. The *Chimæridæ*, which make their first appearance in the Kimmeridge beds, are here as elsewhere represented by *Ischyodus*, which also occurs in the Portland beds, seven species being noticed.

V.—Descrizione di Alcune Cicadeaciæ Fossili Rinvenute nell' Oolite del Alpi Venete, del Barone Achille de Zigno.

THIS small brochure by Baron Zigno, whose larger work we hope hereafter to notice, contains descriptions of eight species of fossil Cycads from the Oolite of the Venetian Alps, one of which, the *Otozamites Bunburianus*, is considered to be identical with the *Otopteris tenuata* from the Oolite shale of Cloughton, Yorkshire.

IV.—SCIENTIFIC JOURNALS.

The Popular Science Review, for October, contains a good article by Prof. D. T. Ansted, F.R.S., on "How to make a Geological Section," and an article on the Lobster, by Mr. St. George Mivart, F.L.S., with much else of general interest.

The Quarterly Journal of Science, for October, contains two papers interesting to the geologist; one by the Rev. H. W. Crosskey, "on the Post-tertiary beds of Norway and Scotland," in which the author points out that the physical changes from the Glacial epoch to the present day were generally similar as to succession and variation in both countries, and were gradual, and have left their evidence in the shell-beds as well as in physical phenomena. Mr. Crosskey points out that of the lower series of Glacial fossil shells of Scotland some are only now living in high northern latitudes, while the second great series of Glacial beds indicates a change from the extreme arctic conditions of the preceding period. The second paper, "on the iron pyrites mines of Andalusia," is the result of a hasty visit to the country; embodying also information derived from the Spanish, French, and English works on the district. The metalliferous zone is in the slaty Silurian rocks associated with porphyritic masses. The ore-vein is mostly a homogeneous mass, sometimes 70 metres across, surrounded by a sahlband, and consists of granular iron pyrites, with a very small mixture of copper pyrites, some silica, and traces of lead and zinc, and covered near the surface with a thick gossan, varying from 20 to 160 feet. It is worked at five localities—St. Domingo, Tharsis, Coronada, Rio Tinto, and Buitron. At the latter place it is estimated that there are 4,000,000 tons of ore above the level of the present adit.

REPORTS AND PROCEEDINGS.

Geological Society of London.—Nov. 11th, 1868.—Prof. T. H. Huxley, LL.D., F.R.S., President, in the chair. 1. "Note comparing the Geological Structure of North-western Siberia with that of Russia in Europe." By Sir R. I. Murchison, Bart, K.C.B,, G.C. St.S., F.R.S., V.P.G.S., &c.

Count A. von Keyserling had communicated to the author the following facts:—The district between the rivers Lena and Jenissei is occupied by Upper Silurian rocks of the same type as those found in the region of Petchora, and by Carboniferous rocks containing seams of coal. The chief Secondary deposits are of Oolitic or Liassic age, and agree with those of the Petchora region, which is the next adjacent tract on the west to the Siberian region in question. Similar rocks are found in Spitzbergen. The banks of the Jenissei are covered with Post-pliocene accumulations similar to those found near Archangel. It is thus seen that the vast, slightly undulating, and to a great extent horizontal and unbroken formations, each of which occupies so wide an area in European Russia, are repeated on the eastern side of the Ural Mountains. In this range of mountains only are to be found igneous and erupted rocks.

In conclusion, Sir Roderick referred to the discovery of fossiliferous white Chalk in parts of the great Sarmatian plain by M. Grewinck.

Discussion.—Sir Roderick Murchison, in explanation of the paper, referred to a geological map of Russia, and gave a general sketch of the bearing of the paper on the previously known geology of that country. He mentioned the discovery by M. Grewinck of beds of brown coal containing amber, and overlying true Chalk. The amber in the Baltic had been supposed to have been washed out of beds beneath the sea; but Count Keyserling has suggested that the amber may have been brought down by the rivers from the interior, and deposited in the Baltic. Sir Roderick also called attention to the absence of igneous rocks in Russia to the west of the Ural Mountains.

2. "On a section of a Well at Kissingen." By Prof. Sandberger, For. Corr. G.S.

Taking as a starting-point a bed of dark-blue limestone, the author proceeded to describe the various beds passed through in sinking the Schönbern well, both as regards their petrological characters and chemical constitution. He considered that this bed is on the same horizon as the uppermost Plattendolomite of the Zechstein formation in the Harz and Thuringia. Above this lie the lowermost beds of the Bunter (containing dolomites), and below it the upper part of the Zechstein formation. Below the Plattendolomite of the Zechstein, from the depth of 1,740 feet to 1,884 feet, follow the saliferous beds.

Discussion.—Sir R. I. Murchison differed from the author, inasmuch as he regarded the whole of the dolomite rocks mentioned as belonging to the Permian system, and not to the Bunter Sandstein proper.

3. "On the formation of Deltas; and on the evidence and Cause of great Changes in the Sea-level during the Glacial Period." By Alfred Tylor, Esq., F.L.S., F.G.S., &c.

The first portion of this paper was devoted to a comparison of the delta-deposits of the Po, Ganges, and Mississippi. The surfaces of these deltas and the alluvial plains above them were compared together; and it was stated that a parabolic curve drawn through the extremities of each river, and through one point in its course, nearly represents its longitudinal section—the greatest deviation being 30 feet in some of the largest deltas.

The littoral deposits around Great Britain described by Mr. Godwin-Austen were next investigated, to ascertain whether the hypothesis of a fall of 600 feet in the sea-level is tenable. The ice-cap at the poles was also alluded to as a probable cause of a great reduction of the sea-level during the Glacial period.

The upper 600 feet of deposits in the Pacific Ocean, made by coral-zoophytes, were quoted as cases which might be explained as well by oscillation in the sea-level as by the received hypothesis of the subsidence of the sea-bottom.

Prof. E. Forbes's investigations into the origin of the fauna and flora of the British Isles were next alluded to, and the author considered that the hypothesis of a fall in the sea-level better accords with the facts of migration than Forbes's suggestion of changes of the level of the land and sea-bottom.

The origin and age of the English Channel was discussed at some length; and the occurrence of the Crag and fossiliferous gravels and raised beaches near the same level, although of different ages, together with the evidence afforded by the dredging up of fresh-water and littoral shells in the North Sea and English Channel, were adduced in support of the theory of the depression of the sea-level.

The parabolic curve not only represents the curve of deposition; for the author had measured other sections, and found that the curves of denudation and deposition approximate often to that of the parabola.

Discussion.—The President called attention to the fact that in the neighbourhood of coral reefs the dead corals extend to such a vast depth that, supposing them all to have been formed near the surface, and that surface only lowered by abstraction of water to the Poles, the accumulation of ice must have been so great as to become incredible.

Sir Charles Lyell had already suggested to Mr. Croll that, assuming the accumulation of ice at the Pole depressing the centre of gravity of the earth, the submergence that would have resulted, had the quantity of water in the sea remained the same, would to some extent be counteracted by the reduction in volume consequent on the formation of the ice. With regard to the delta of the Mississippi, the data on which he argued had considerably altered since first he wrote on the subject, inasmuch as recent calculations had doubled the estimated volume of water flowing into the sea, and thus it was capable of producing the same effect in half the previously calculated time. The progress of the delta at any spot was of necessity variable, as the position of the mouth changed. The American engineers had allowed only 40 feet as the depth of the fluviatile deposits, whereas, from boring, Sir Charles had concluded it to be at least 500 or 600 feet. There was now reason to suppose that it was much more, possibly as much as 1500 feet. This being the case, notwithstanding the amount of work done by the river being doubled, his calculation as to the time required for the formation of the delta might not after all be so excessive.

Mr. Prestwich suggested that Mr. Croll's theory only involved a transfer of ice from one Pole to the other, and not a diminution of volume of the sea. The raised beaches round the coast of Britain varied considerably, and were not on one uniform horizon, as they would have been had they resulted from a lowering of the sea. The elevation of the old sea-beds during the Glacial period were not accounted for by any supposition of the mere alteration in the volume of the sea.

Mr. Evans pointed out that, the *Cyrena* being a fresh-water shell, its position at a certain level was not connected directly with the height of the sea. He doubted the curve of the rivers being in all cases parabolic.

Mr. Mallet had already remarked that the beds of rivers, especially near their sources, appeared to assume curves closely allied to a parabola. He considered that the form was due rather to the elevatory forces than to erosion. He doubted, however, whether they were really parabolic curves, or, indeed, any other mathematical curve.

Mr. Tylor replied that he had not found definite evidence as to the extension of corals downwards to such a depth as that mentioned by the President. With regard to oscillation, he had merely treated of the southern part of England. The opening of the Straits of Dover would account for the existence of beaches above the present level, as the tides would have previously risen higher. The parabolic curve was that which, by actual comparison, coincided most closely with the longitudinal section of the banks of the rivers Po, Mississippi, and Ganges.

NORWICH GEOLOGICAL SOCIETY.—I. The monthly meeting of this society was held at the Museum on October 6th, and was well attended. The President (the Rev. J. Gunn, F.G.S.) was in the chair.

Mr. Charlesworth, F.G.S., read the following paper, "On the Prospective Annihilation of the Suffolk Red Crag as a Geological Formation, with a few Remarks about the Red Crag Phosphatic

Stones, 'Coprolite.'" He thought that remarkable deposit to which in 1835, he gave the name "Red" Crag, and which forms one of the well-known group of Tertiary formations that are spread over a limited area in the counties of Norfolk, Suffolk, and Essex will possibly have, at no very distant day, to be expunged from an enumeration of the strata that now make up the list of the British Fossiliferous Rocks. The destruction of this deposit is being brought about, partly by the encroachment of the sea, as at Harwich, where the Crag, which in Dale's time 1730 capped the London Clay cliffs, and furnished that author with the shells, the engravings of which constitute the earliest published figures of Crag Fossils, but of which Crag not a vestige is now to be seen; and partly by the artificial breaking up of the Crag to get at the layer of Phosphatic Nodules which lies at its base, and the commercial value of which to agriculturalists, under the misnomer "coprolite," forms the famous discovery of the late Professor Henslow. Hence it is allowable to speculate on the high value which collections of Red Crag fossils will bear when this stratum becomes a thing of the past, known to coming generations of geologists only from what they may read in books, or gather from the examination of such Crag specimens as are preserved in Geological Museums. When the Coprolite workings are closed, no such collections of Red Crag fossils can ever be made as are made now. All the most productive fossiliferous portions of the Red Crag will then have been mixed up with the overlying sand, gravel, and vegetable soil, which, shovelled up by the coprolite miners with the Crag, in one common mass, are thrown back into the diggings, as field by field is trenched over, and the black treasure taken out.

Mr. Charlesworth referred to the abundant evidence of a Mammalian Fauna in the Suffolk Red Crag, having been furnished through the coprolite workings, and stated that this addition to our knowledge of Red Crag Palæontology is sometimes advanced as an objection to the designation "Mammaliferous" for the Crag in Norfolk, with its extension to Southwold and Thorpe, in Suffolk. But those who advance this objection lose sight of the fact that this Norfolk Crag has produced its abundance of Mammal teeth and bones without the trenching and sifting process which, since 1840, has enlightened geologists with respect to the occurrence of Mammal teeth and bones in the Suffolk Red Crag, and that were the Norfolk Crag subjected to the "sifting" process, its Mammal remains would so greatly exceed those of the Suffolk Red Crag, as fully to justify the applicability of his name "Mammaliferous," without meeting considerations arising out of the law of priority, so strongly insisted upon by the highest authorities in Natural History Science.

In regard to the origin of these phosphatic nodules;—the so-called Crag coprolites. The idea of the nature of these nodules being coprolitic originated with Professor Henslow—a mistake, but one, perhaps, of the happiest mistakes ever made by a man of science: for had not Professor Henslow believed these stones to be coprolites (fossil dung), he would never, in all probability, have had them analyzed, and the phosphatic nature and consequent agricultural value of these stones might possibly for centuries to come have remained unknown.

He had no theory of his own to advance in explanation of the formation of Crag coprolite stones, though it appeared to him that they had some points in common with the occurrence of flint stones in Chalk. In the Chalk we see flint setting, so to speak, upon the root of a sponge or ventriculite, and forming around it an oval or spherical mass, while the rest of the ventriculite, when circumstances often admit of the observation being made, can be traced in the contiguous mass of Chalk. But as the workmen in chalk quarries break up the chalk in small pieces, a ventriculite in connexion with its flint-invested root is rarely presented to our notice, Now there were no rooted ventriculites in the Crag Sea for the Crag phosphatic or so-called coprolitic matter to adhere to; but there were an abundance of sharks' teeth with roots, and upon these roots or fangs we find the phosphatic stone clinging in a more or less spherical mass, while the greater portion of the organic body—that is, the tooth proper, has none of this phosphatic investment. And when the Crag is broken up, were these teeth delicate and fragile, they would, after the fashion of the Chalk ventriculites, break away from their stone-invested roots.

Chalk flint-stones when broken often present to us enclosed shells, sharks' teeth, and other organic bodies. But in all cases these flint-enclosed organic bodies are of the same species as the organic bodies found in the Chalk itself. It is otherwise with the organic bodies enclosed in the Crag *phosphatic* stones. We find these stones lying in immediate contact with numerous shells, but if we break a phosphatic stone, and find a shell enclosed, this Crag stone-enclosed shell is not of the kind found in the Crag, but of some species found in the underlying and much more ancient formation than Crag, the London Clay. And though the shark's teeth which are enclosed in these Crag stones may be quoted as an exception to this rule, yet they really support it, for there are two groups of shark's teeth found in the Crag, one group containing species peculiar to the Crag, the other containing species which are found in both the Crag and the London Clay. Now, whenever a Crag shark's tooth is in a phosphatic nodule, or even if it have the smallest piece of phosphatic matter investing it, it is invariably a tooth of the London Clay group. Again, no phosphatic stone has ever been seen investing one of the many thousand teeth of the whale tribe which have turned up at the diggings, and it is a well-known fact that these Cetacean teeth are not found in the London Clay, but are a specialty of the Crag; so that we may set it down as a rule, so far as the Crag is concerned, that we only find Crag fossils in union with phosphatic stone when the fossil is of a London Clay species: and this leads to the inevitable conclusion that all the Crag coprolite stones were originally in the London Clay. The soft London Clay itself, when it formed the bed of the Crag ocean, would be abraded by the action of tides and currents, bringing about the separation from it of the hard and heavy phosphatic stones. These stone removed from their parent bed, became a portion the Crag, then in process of formation upon and

II.—The third annual meeting of the Norwicl was held at the Royal Hotel, on October 20th. men met at tea, under the presidency of the Rev.

The re-election of the rev. gentleman as Presi acclamation.

The President thanked the members most hear in which they had expressed their wish to re-elec a few remarks on the proceedings of the Socie year. He first desired to express his painful fee a very esteemed member of the Society—he allu S. W. King, of Saxlingham. In one sense he v of Norfolk geology, for he had not devoted h geology of this county more than a few years. attention previously to the geology of Scotland (the President) had the good fortune to be witl panying Sir Charles Lyell and Dr. Hooker on an e Mr. King was then so struck with the grandeur that he instantly set about collecting, and in a sh together a very fine collection, which was to be pl street Museum.

Literary and Philosophical Society, New On the 6th November, Mr. T. P. Barkas read a p "On the Fauna of the Low Main Coal Seam, No

"The genus *Diplodus* merits special attention. from the peculiar large double crowns which a supposed teeth of the fish. *Diplodus* is a genus and is described by him in his great work on Fo scribes and figures two species, *Diplodus gibbos* both of which are very abundant in the shale Main Coal. The form of *Diplodus* when once s forgotten. In addition to the two long crowns shorter and sharper central process or tooth. *Diplodi* have three pointed elevations, but I ha possession which have four, and one has as man cesses or elongated prominences. It is yet a mo the *Diplodi* are teeth or dermal tubercles. Pro recent pamphlet on the Fossils of the Low Mai sections of the *Diplodi* to teeth. Messrs. Hanc one of their recent papers in the Annals of Na to the opinion that they are dermal tubercles.

Professor Kner, of Vienna,[1] in a work on *Xenaca Dechenii*, which genus is said by Sir Philip de be generally identical with *Pleuracanthus*, and *Diplodus*. These references and generalizations probable, by the fact that Professor Kner has found *Diplodi* placed in rows in the jaws of a Fish which he designates *Xenacanthus*. The Professor asserts that "in the lateral parts of the jaws they are arranged in 28–29 rows, of 6–8 in each transversely, and on the outer maxillary they form 4 rows of 6–8 in each." If the observations of Professor Kner are perfectly reliable, the question is settled, and the *Diplodi* are teeth, but the evidence, so far as regards our Coal-measure specimens, points rather in the direction of their being tubercles, inasmuch as they are often found in large diffused patches, without any appearance of arrangement, and without the slightest indication of corresponding jaws in these localities. This evidence, however, is negative, and no merely negative evidence is of value in the presence of that which is positive. The only questions therefore to be determined are: Are the specimens described by Professor Kner generically the same as those found in our Coal-measures, and is the arrangement he describes so satisfactory as to be conclusive? It is acknowledged that many of the Professor's specimens are indistinct and dubious, and the question may without offence be asked, "Was the specimen jaw and teeth, or supposed teeth dubious or clear?" The writer of the review of the work on *Xenacanthus* in the GEOL. MAG. for August, observes: "Our author thinks that the strata in England and North America, containing the teeth of *Diplodus* and spines of *Pleuracanthus*, ought perhaps, on closer examination, also to be referred to the Permian system, and not to the Carboniferous. In this supposition Professor Kner is manifestly wrong, as *Diplodi* are among the commonest fossils of our Northumberland Coal-measures. On the table before us there are specimens of *Diplodi*, and some large slabs in which large bones are present and numerous *Diplodi* scattered about. There is also a mass of comminuted bones, in the midst of which *Diplodi* lie buried in considerable number.

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[1] See Geological Magazine, Vol. V., 1868,

CORRESPONDENCE.

INTERNAL FLUIDITY OF THE EARTH.

SIR,—In this month's GEOLOGICAL MAGAZINE no less than three articles occur treating of the internal constitution of the earth, and the manner of "Formation of Mountain Chains."

Mr. Fisher explains the "Elevation of Mountain Chains" by an outer crust becoming unsupported through the contraction by cooling of the inner parts of the earth, the intermediate layer then (by diminution of pressure) becoming the most fluid portion.

M. Delaunay says that, if the motion be slow, the rotation of a solid crust would be accompanied by that of the fluid interior, and therefore that no idea of the thickness of this outer crust can be formed from the phenomena of precession and nutation.

Mr. Shaler argues that, "if the effect of pressure in promoting solidification at the earth's centre were greater than the effect of heat in resisting solidification, then the mass would congeal first at the centre, and solidification extend thence towards the circumference;"

and in summing up says, "that the most probable hypothesis in the present state of our knowledge of the earth, is that it consists of an immense solid nucleus, a hardened outer crust, and an intermediate region, of comparatively slight depth, in an imperfect state of igneous fusion."

This last is precisely the state of the earth as imagined by Halley when endeavouring to account for the phenomena of the magnetic needle. To account for these phenomena he assumes the existence of four magnetic poles, two in each hemisphere. the relative positions of which undergo a constant change; to effect this he makes one pole in each hemisphere to be situated on an external crust, and the two other poles on an interior mass, separated from the crust by a fluid medium; this interior mass he supposes to revolve more slowly by an extremely small quantity than the outer crust. Subsequently Hanstein examined the subject, and came to the same conclusion with Halley as to the existence of four poles; these he made to be all of unequal magnetic force, and to revolve round the terrestrial poles at unequal periods; the periods being as near as possible, allowing for errors of observation, all multiples of that mystic number 432, the weakest north pole revolving in 432 × 2 = 864 years, and the strongest in 432 × 4 = 1728 years, the weakest south pole in 432 × 3 = 1296 years, and the strongest in 432 × 10 = 4320 years. While, curious enough, the least common denominator of these four periods is 432 × 60 = 25,920, which is the period of the revolution of the precession of the equinoxes; therefore the shortest time for the four magnetic poles to complete a cycle is equal to the precessional period of revolution.[1]

Whether such a thing gives any real clue to the present state of the interior of our globe is a question which I would leave others to determine for themselves; at the present time I would merely draw attention to the similarity that exists between the supposed internal condition to account for magnetic phenomena by Halley and Hanstein. and that condition as put forward, to account for the "Elevation of Mountain Chains," by Messrs. Fisher and Shaler in their recent articles in this Magazine.

M. Delaunay shows that a slowly-revolving crust would take with it a contained fluid. It would be an interesting thing to know whether, supposing a solid occupied the centre of the fluid, it also would revolve with the said fluid at the same or a slower rate.

J. Clifton Ward.

York, *Oct.* 19*th*, 1868.

HETEROPHYLLIA MIRABILIS AND *H. LYELLI.*

Sir,—Mr. De Wilde's letter is quite satisfactory. Had the appearances referred to by Mr. Young (Geol. Mag. Oct. p. 448. etc.) been present in Dr. Duncan's specimens, neither he nor Mr. De Wilde would have failed to notice them. It is therefore to be regretted that you did not submit Mr. Young's specimens to that artist, who has an interest in the matter, rather than to Mr. Fielding, who has none. The testimony which that gentleman volunteers is, however, of value as confirming the only inference possible from the statements and figures, that the specimens of *Heterophyllia* are variously preserved, and that Mr. De Wilde has not seen all the varieties.

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[1] See Chap. viii. of "Rudimentary Magnetism," by Sir Wm. Snow Harris.

I am unaware, of course, of your reasons for adopting a somewhat unusual style of comment on Mr. Young's paper. He does not, however, as you say, "object to a discovery because it is an anomaly." He thinks the appearances may be otherwise interpreted, and that so unexpected a phenomenon as articulated spines on a coral requires more evidence in its support than has been adduced. Anomalies in other groups of animals furnish no argument in support of this particular one. Mr. Young thinks his specimens justify him in taking exception to Dr. Duncan's paper on two grounds, 1st, that *H. Lyelli* and *H. mirabilis* are not distinct species, 2nd, that neither possessed articulated spines. The criticism of published species is neither an unusual nor a hurtful proceeding, and I should have been unwilling to interfere in the matter which rests entirely between Dr. Duncan and Mr. Young, but that, having seen the specimens, I am satisfied that the difference of opinion, at least on the second of Mr. Young's criticisms, is due to difference in the state of preservation of the fossils.

JOHN YOUNG, M.D.

HUNTERIAN MUSEUM, GLASGOW, 18*th November*, 1868.

[ERRATUM.—In the heading to Mr. J. Young'sp aper on *Heterophyllia* (p. 448) in our October Number, we styled him "Curator of the Hunterian Museum, Glasgow." We find we were in error. Professor John Young, M.D., is Keeper of the Museum, and Mr. J. Young is Assistant-Keeper.—EDIT.]

HETEROPHYLLIA MIRABILIS, DUNCAN.

SIR,—Having read, in the November number of the GEOLOGICAL MAGAZINE, the observations of Messrs. De Wilde, Fielding, and yourself, upon the so-called articulation of the hooklets on *Heterophyllia mirabilis*, I now beg to state that the specimens of this coral which I sent to you, and which are referred to in Mr. Fielding's remarks, are of a mixed character, and were intended to illustrate the various conditions in which it is found, such as the various diameters the coral assumes, and the variation in form of the horizontal section. Others show the rounding of the bases of the spines when worn, presenting then the appearance of rounded tubercles; while others show the spines lying in position in the shale, or with their fractured bases projecting irregularly from the stem of the corallum.

The remarks which I formerly made were based partly upon these and other longer specimens in my possession, and I am satisfied, after a further examination of all the best preserved specimens I can find, that what I have stated in my paper is correct, viz., that the hooklets were not articulated upon tubercles, and the mere rounding of the base of the spines, so as to resemble tubercles, seen upon some specimens, stands for nothing in the face of the important fact which numerous others go to prove, viz., that these tubercles are not rounded in the better preserved specimens, and that they are in fact only the fractured bases of the spines or hooklets.

Mr. De Wilde states that if the hooklets were solid appendages attached to the stem, he would not expect them to break away so regularly as they seem to have done, because he says the hooklets are stoutest at their base. But he must remember that although this be their thickest part, yet it is their weakest point in their relation to the stem. As points in illustration—twigs torn from the stem of a plant, naturally break close to their attachment with the stem, yet this is also their thickest point; and the spines of the *Productæ* found in our soft shales, are seen in most cases to be fractured close to their attachment to the shell, owing to the pressure they have sustained. But this fracturing of the spines by pressure is not always regular in its distance from the organism, either in the *Productæ* or the coral in question, as some of my specimens in your possession clearly show. There are several other considerations that might be urged against the supposed articulation of the hooklets upon tubercles, but the fear of encroaching too far upon your space forbids me from entering upon them at present.

John Young.

Hunterian Museum, Glasgow,
November 5, 1868.

ON *HETEROPHYLLIA.*

Sir.—I have read Mr. J. Young's communication to the Geol. Mag. concerning *Heterophyllia* and Mr. De Wilde's letter also. Mr. Fielding's note must be satisfactory to the able artist who drew from nature the tubercles and spines of *Heterophyllia mirabilis, nobis* for the Phil. Trans. not for the Proceedings, as Mr. J. Young asserts), but really the slightest possible examination of the specimens proves that the appearance of irregular fracture of the spines is the exception, and that which I have described is the rule. The irregular fracture has been produced by pressure, which has acted more upon the base of the tubercles than upon the junction of the hooklets with the tubercles. Probably some anchylosis had occurred and the joint had been destroyed.

I am content to abide by the decision I came to whilst the *Heterophylliæ* in the Hunterian Museum of Glasgow were still called *Serpulæ*, and to consider *H. Lyelli* and *H. mirabilis* very interestingly separate species. It is very remarkable that Mr. J. Young did not favour science with an elaborate essay upon these very peculiar corals long before their importance became manifest to his able fellow geologist, Mr. J. Thomson, and to me. Perhaps the enormous amount of work still required to be undergone amongst the comparatively unknown fossils of the Scottish Coal Field has frightened the worthy sub-curator. I would beg of him to cheer up and to try just "a wee" of original palæontological research. When he has described one species, his criticisms upon the works of those who are hard at work at Scotch fossils will be more appreciated. At present his criticisms are long but not strong.—P. Martin Duncan.

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